

SECTION 400. SURFACE COURSES, PAVEMENTS, REHABILITATION AND SHOULDERS

BITUMINOUS SURFACES AND PAVEMENTS

SECTION 401. BITUMINOUS TREATED EARTH SURFACE

401.01 Description. This work shall consist of preparing an earth surface and applying bituminous materials.

401.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Bituminous Materials (Note 1)	1009.01-1009.04, 1009.09-1009.11
(b) Blotter Aggregate	1004.06

Note 1. The Contractor may use any one of the types of bituminous materials as shown in the table below. When more than one grade is shown on a particular type, the Engineer reserves the right to specify the grade which shall be used.

Bituminous Material	Grade
Medium Curing Liquid Asphalt	MC-30, MC-70 MC-250, MC-800
Slow Curing Liquid Asphalt	SC-70, SC-250 SC-800
Road Oil	E-2, E-3, E-4

CONSTRUCTION REQUIREMENTS

401.03 Preparation of Earth Surface. The earth grade shall be reshaped prior to the application of the bituminous materials, and at the time the bituminous material is applied, the surface shall be smooth, well compacted, free from sod, vegetation, excess loose dirt or dust, and shall be dry enough that the wheels of the distributor will not rut or mar the surface. As soon as the road is closed to traffic and before application of the bituminous material, excess dust and loose dirt shall be either removed from the surface, or the surface wetted sufficiently to cause the excess dust or loose dirt to be consolidated with the solid soil beneath. If the removal of the dust and loose dirt leaves an uneven or rough surface, the earth grade shall be restored to a condition satisfactory to the Engineer.

401.04 Weather Limitations. This work shall be done between May 1 and October 1. Bituminous materials shall be applied only when the temperature of the air in the shade is above 15 °C (60 °F). No work shall be started if local conditions indicate that rain is imminent.

This work may be done between October 1 and October 30 providing the temperature of the air for three consecutive days immediately preceding the day of application has been, (1) above 15 °C (60 °F) in the shade each day, (2) a minimum of 5 °C (40 °F) and (3) the temperature of the air in the shade at time of application is above 15 °C (60 °F).

401.05 Quantity of Bituminous Material. The total quantity of bituminous material applied shall be not less than 1 L/sq m (0.25 gal/sq yd) nor more than 3 L/sq m (0.75 gal/sq yd), as required by the Engineer.

401.06 Application of Bituminous Material. The temperature of the bituminous material at the time of application shall be such that it will spray uniformly without clogging the spraying nozzles and shall be applied within the temperature ranges indicated in Article 403.07. All flames shall be extinguished during application of the bituminous material.

The bituminous material shall be applied by means of a pressure distributor meeting the approval of the Engineer.

Where the total quantity of bituminous material to be applied is 2 L (0.4 gal) or more per sq m (sq yd), it shall be applied in two applications. Sufficient time shall elapse between successive applications to permit the bituminous material to be absorbed to such extent that the soil will not adhere to the wheels of the distributor.

401.07 Application of Blotter Aggregate. When specified, an application of a blotter aggregate shall be applied to the treated surface immediately after the application of the bituminous materials. The blotter aggregate shall be spread evenly with an aggregate spreader, meeting the approval of the Engineer, over the entire surface at the rate of 8-16 kg/sq m (15-30 lb/sq yd), the exact rate to be specified by the Engineer. The blotter aggregate shall be applied by spreader equipment operating backwards over the aggregate being placed. Hand spreading will be permitted only when approved by the Engineer.

401.08 Opening to Traffic. The road shall be opened to traffic according to Article 701.05(c)(4).

401.09 Method of Measurement. The bituminous material will be measured as specified in Section 1009. The unit of measurement will be shown on the plans.

The blotter aggregate will be measured in metric tons (tons) according to the requirements of Article 311.08(b), except payment will not be made for blotter aggregate in excess of 110 percent of the amount specified by the Engineer.

401.10 Basis of Payment. This work will be paid for at the contract unit price per liter (gallon) for BITUMINOUS MATERIAL APPLIED or at the contract unit price

per metric ton (ton) for BITUMINOUS MATERIAL APPLIED and per metric ton (ton) for BLOTTER AGGREGATE.

SECTION 402. AGGREGATE SURFACE COURSE

402.01 Description. This work shall consist of furnishing and placing one or more courses of aggregate upon a prepared subgrade.

402.02 Materials. Materials shall meet the requirements of the following Article of Section 1000 - Materials:

Item	Article/Section
(a) Aggregate	1004.04

Note: Reclaimed asphalt pavement (RAP) may be used as aggregate in surface course for temporary access entrances. The RAP material shall be reclaimed asphalt pavement material resulting from the cold milling or crushing of an existing hot-mix bituminous concrete pavement structure, including shoulders, which was built under state contract and met Department specifications at the time of original placement. RAP containing contaminants such as earth, brick, concrete, sheet asphalt, sand, or other materials identified by the Department will be unacceptable until the contaminants are thoroughly removed. The Contractor shall inform the Engineer as to the location of the originally placed pavement prior to the RAP being used. The RAP shall also meet the following requirements:

One hundred percent of the RAP material shall pass the 37.5 mm (1 1/2 in.) sieve. The RAP material shall be reasonably well graded from coarse to fine. RAP material that is gap-graded or single sized will not be accepted.

402.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Tamping Roller	1101.01
(b) Pneumatic-Tired Roller	1101.01
(c) Three-Wheel Roller (Note 1)	1101.01
(d) Tandem Roller (Note 1)	1101.01
(e) Spreader	1102.04
(f) Vibratory Machine (Note 2)	

Note 1. Three-wheel or tandem rollers shall weigh 5.5 to 9 metric tons (6 to 10 tons) and shall weigh not less than 35 N/mm (200 lb/in.) nor more than 57 N/mm (325 lb/in.) of width of the roller.

Note 2. The vibratory machine shall meet the approval of the Engineer.

CONSTRUCTION REQUIREMENTS

402.04 Subgrade. The subgrade shall be prepared according to Section 301 except Article 301.06 will not apply.

402.05 Type A Requirements. Aggregate surface course, Type A, shall be constructed according to Article 351.05(a) and (b) except the bearing ratio requirements shall not apply.

402.06 Tolerance in Surface Course Type A Thickness. The surface course shall be constructed to the thickness shown on the plans. Thickness determinations will be made at such points as the Engineer may select. When the constructed thickness is less than 90 percent of the thickness shown on the plans, aggregate shall be added to obtain the required thickness.

402.07 Type B Requirements. Any one or two gradations of the material specified in Article 1004.04 shall be used except where two gradations of material are used, the change shall not be made at more than one location on the section.

The surfacing material shall be deposited on the subgrade by means of a spreader.

The equipment used shall be such that the required amount of material will be deposited uniformly along the central portion of the roadbed.

The material which has been deposited shall be spread immediately to the plan cross section. Hauling shall be routed over the spread material so it will cover the entire width of surface. If the equipment used in the hauling operations causes ruts extending through the spread material and into the subgrade, and the subgrade material is being mixed with the surfacing material, the equipment shall be removed from the work or the rutting otherwise prevented as directed by the Engineer.

The Contractor shall keep the surface smooth by dragging or blading as many times each day as the Engineer may direct.

Holes, waves, and undulations which develop and which are not filled by blading shall be filled by adding more material.

402.08 At Bridges, Railroad Grade Crossings, and Existing Pavement. The surface course adjacent to bridges, railroad grade crossings, and existing pavement shall have a trench type cross section of the same thickness as the typical section, with the surface at the established grade. The width at bridges and railroad grade crossings shall be 600 mm (2 ft) wider than the portion of the featheredge section having a uniform thickness. At existing pavement, the width shall be as shown on the plans or as directed by the Engineer. The transition from the featheredge design to the trench design at the bridge, railroad grade crossing or existing pavement shall be made at a uniform rate within a distance of 15 m (50 ft). The cost of excavation in this transition will be considered as included in the cost of surfacing.

402.09 At Side Roads, Entrances, and Mailboxes. The same type and gradation of material used for constructing the surface course shall be used at side roads, entrances, and mailbox turnouts.

402.10 For Temporary Access. The Contractor shall construct and maintain an aggregate surface course for temporary roads, approaches, and entrances according to Article 402.07 and as directed by the Engineer.

The same type and gradation of material used to construct the temporary access shall be used to maintain it.

When use of the temporary access is discontinued, the surface aggregate used in its construction shall be removed and utilized in the permanent construction or disposed of according to Article 202.03.

402.11 Shaping, Trimming and Finishing. All shaping, trimming, and finishing shall be according to Section 212.

402.12 Method of Measurement. Aggregate used for aggregate surface course will be measured for payment in metric tons (tons), cubic meters (cubic yards), or square meters (square yards) of the thickness specified, according to the requirements of Article 311.08.

402.13 Basis of Payment. This work will be paid for at the contract unit price per metric ton (ton) for AGGREGATE SURFACE COURSE, TYPE A, or AGGREGATE SURFACE COURSE, TYPE B; or at the contract unit price per cubic meter (cubic yard) for AGGREGATE SURFACE COURSE, TYPE A; or AGGREGATE SURFACE COURSE, TYPE B; or at the contract unit price per square meter (square yard) for AGGREGATE SURFACE COURSE, TYPE A; of the thickness specified.

The unit price bid for Aggregate Surface Course, Type B, shall include constructing, maintaining, and removing temporary access and the utilization or disposal of the removed material.

SECTION 403. BITUMINOUS SURFACE TREATMENT (CLASS A-1, A-2, A-3)

403.01 Description. This work shall consist of the construction of a single or multiple course bituminous surface treatment as indicated below:

- (a) A-1. A-1 shall consist of a bituminous seal coat material and a seal coat aggregate.
- (b) A-2. A-2 shall consist of a prime coat, a bituminous cover coat material and a cover coat aggregate, and a bituminous seal coat material and seal coat aggregate.
- (c) A-3. A-3 shall consist of a prime coat, two separate applications of a bituminous cover coat material and cover coat aggregate, and a bituminous seal coat material and seal coat aggregate.

403.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Cover Coat Aggregate	1004.03
(b) Seal Coat Aggregate (Note 1)	1004.03
(c) Bituminous Materials (Note 2)	1009

Note 1. For A-1 surface treatment, the Special Provisions will specify which of the two aggregate gradations itemized in Article 1004.03 shall be used.

Note 2. For A-1 surface treatment, the Special Provisions will specify the types and grades of bituminous materials to be used. For A-2 and A-3 surface treatments, the Contractor may use any one of the types of bituminous materials shown in the following table. When more than one grade is shown for a particular type, the Engineer reserves the right to specify the grade which shall be used.

Type of Construction	Bituminous Materials Recommended for Weather Conditions Indicated	
	Warm [15 °C to 30 °C]* [(60 °F to 85 °F)]*	Hot [30 °C Plus]* [(85 °F Plus)]*
Prime	MC-30, PEP	MC-30, PEP
Cover Coat And Seal Coat	RS-1, RS-2, CRS-1, CRS-2, RC-800, RC-3000, MC-800, MC-3000, SC-3000, HFE- 90, HFE-150, HFE-300	RS-1, RS-2, CRS-1, CRS-2, RC-800, RC-3000, MC-800, MC-3000, SC-3000, PG46-28, PG52-28, HFE-90, HFE-150, HFE-300

*Temperature of the air in the shade at the time of application.

403.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Pneumatic-tired Roller	1101.01
(b) Mechanical Sweeper	1101.03
(c) Aggregate Spreader	1102.04
(d) Heating Equipment	1102.07
(e) Pressure Distributor	1102.05

CONSTRUCTION REQUIREMENTS

403.04 Weather Limitations. This work shall be done between May 1 and October 1. Bituminous materials shall be applied only when the temperature of the air in the shade is above 15 °C (60 °F) No work shall be started if local conditions indicate that rain is imminent.

This work may be done between October 1 and October 30 providing the temperature of the air for three consecutive days immediately preceding the day of application has been: (1) above 15 °C (60 °F) in the shade each day, (2) a minimum of 5 °C (40 °F) and (3) the temperature of the air in the shade at time of application is above 15 °C (60 °F).

403.05 Sequence of Work. The sequence of construction operations shall be undertaken as follows:

- (a) Repair and preparation of base or existing surface.
- (b) Application of bituminous material for prime coat (A-2 and A-3 only).
- (c) Alternate applications of bituminous material and aggregate.

403.06 Repair and Preparation of Base or Existing Surface. The base or existing surface shall be prepared according to Section 358.

403.07 Preparation of Bituminous Material. The temperature of the bituminous material at the time of application shall be such that it will spray uniformly without clogging the spraying nozzles and shall be applied within the temperature ranges indicated in the table below. Bituminous material delivered in tank cars may be heated by steam coils; that delivered in mobile tanks may be heated in asphalt tanks or in a pressure distributor. In all cases, precautions shall be taken to avoid danger of fire. If heated in asphalt tanks, the material shall be agitated during the heating period to prevent localized overheating. If heated in a pressure distributor, the material shall be circulated while it is being heated. All flames shall be extinguished during application of the bituminous material. In all methods of heating, means shall be provided to determine the temperature of the material at frequent intervals to prevent it from being overheated or damaged. Emulsified asphalt received in tank cars or mobile tanks shall be agitated to secure uniformity of the emulsion before being used. Penetrating emulsified prime (PEP) shall be thoroughly agitated within 24 hours of application.

Bituminous Surface Treatment (Class A-1, A-2, A-3)		
Type and Grade of Bituminous Material	Spraying Application Temperature Ranges	
	Min./Max., ° C	Min./Max., ° F
PEP	15-55	60-130
MC-30	30-90	85-190
MC-70, RC-70, SC-70	50-105	120-225
MC-250, RC-250, SC-250	75-130	165-270
MC-800, RC-800, SC-800	95-150	200-305
MC-3000, RC-3000, SC-3000	110-175	230-345
PG46-28	135-195	275-385
PG52-28	140-200	285-395
RS-1, CRS-1	25-55	75-130
RS-2, CRS-2	45-70	110-160
MS-2, CMS-2	40-70	100-160
SS-1, SS-1h, CSS-1, CSS-1h	25-55	75-130
HFE-90, HFE-150, HFE-300	60-70	140-160
E-2	30-90	85-190
E-3	50-105	120-225
E-4	75-130	165-270

403.08 Preparation of Aggregate. The aggregates used in the cover coat(s) and the seal coat shall contain no free moisture. Aggregate that is slightly damp shall be spread in place on the treated road surface and shall be permitted to dry to the satisfaction of the Engineer before it is disturbed.

403.09 Application of Bituminous Material. The bituminous material shall be applied with a pressure distributor. A hand spray bar shall be used at places which are not covered by the distributor. The entire length of the spray bar shall be set at the height above the surface recommended by the manufacturer for even distribution of the bituminous material. Any loss of bituminous material in handling due to faulty valves, leaking pipes, overflow due to excess, or other reasons, will be deducted from the amount due the Contractor.

The distributor shall be operated in a manner such that missing or overlapping will be avoided. To prevent overlapping of successive applications of bituminous material at transverse joints, heavy paper shall be spread over the previously applied bituminous material and aggregates. In order to obtain a uniform application of the bituminous material, the distributor shall be traveling at the speed required for the specified rate of application when the spray bar crosses the paper.

Adjacent construction, such as concrete pavement, curb and gutter, bridge floors, raised reflective pavement markers, and bridge handrails, shall be protected by shields, covers or other means. If bituminous material is applied to adjacent

construction either by accident or because of inadequate protection, the Contractor shall remove such material to the satisfaction of the Engineer.

If the Contractor is unable to obtain satisfactory application due to unsuitable or poorly regulated distributing equipment, or to incompetent operators, the Contractor shall immediately replace or repair such equipment, or furnish competent operators.

A spray bar operator shall be present at all times, on the rear platform of the distributor, during the application of the bituminous material.

The spray bar operator may be omitted from the rear platform, if the distributor is of such design that the quantity of bituminous material being placed is mechanically coordinated with the speed of the distributor, and the on-off controls and driver's visibility are such that no overlapping of successive applications of bituminous material and aggregates will occur.

403.10 Application of Aggregates. The cover coat and seal coat aggregates shall be spread evenly with an aggregate spreader over the entire surface being treated. In all cases, the aggregate shall be applied ahead of the truck or spreader wheels. Hand spreading will be permitted only when approved by the Engineer and, when so permitted, the aggregate shall be spread uniformly and at the approximate rate specified. Any ridges of aggregate left by the aggregate spreader shall be smoothed out with hand brooms immediately behind the aggregate spreader.

403.11 Prime Coat. The base shall be surface dry, free from dust and compacted before the prime coat of bituminous material is applied. After the base has been prepared, and when in a warm, dry condition, the bituminous material, as specified for prime in Article 403.02, shall be applied uniformly at the rate of 1 to 2 L/sq m (0.25 to 0.5 gal/sq yd), the rate to be specified by the Engineer. The bituminous priming material shall be applied to a width 300 mm (1 ft) greater on each side of the roadway than the specified width of the finished surface. The prime coat shall be permitted to cure until the penetration has been approved by the Engineer, but at no time shall the curing period be less than 24 hours. Pools of bituminous material occurring in the depressions shall be broomed or squeegeed over the surrounding surface the same day the prime coat is applied. At no time during the period of curing shall traffic be allowed upon the primed surface of the road. At locations where the prime coat has failed, it shall be repaired in a manner satisfactory to the Engineer. If the primed surface is damaged by the Contractor's operations, he/she shall repair and roll it at the Contractor's expense. The prime coat shall be maintained at all times until the cover coat is constructed. If required by the Engineer, the primed surface shall be swept prior to constructing the cover coat.

403.12 Cover Coat. Bituminous material for the cover coat shall not be applied until the previous application is acceptable to the Engineer.

At the beginning of each day's work, no bituminous material shall be applied until there is sufficient cover coat aggregate in trucks at the work site to completely cover the first application of bituminous material. The amount of surface area covered by each successive application of bituminous material shall be determined by the Engineer. In no case shall this area be greater than can be covered with cover coat aggregate and given the initial rolling while the bituminous material is still in condition to hold the aggregate.

The bituminous material, as specified for cover coat in Article 403.02, shall be applied uniformly over the surface at the rate of 1 to 2 L/sq m (0.20 to 0.5 gal/sq yd), the rate to be specified by the Engineer. Immediately following the application of the bituminous material, the cover coat aggregate shall be spread over the treated surface at the rate of 8 to 14 kg/sq m (15 to 25 lb/sq yd), the rate to be as specified by the Engineer.

When the aggregate is dry as specified in Article 403.08, the entire surface shall be rolled immediately with a pneumatic-tired roller. Rolling shall proceed in a longitudinal direction beginning at the edges and progressing toward the center, overlapping on successive trips by at least 1/2 the width of the roller. The roller shall be operated at a speed which will not cause the aggregate to be displaced. The aggregate shall then be rolled with a separate pneumatic-tired roller until the aggregate is properly seated in the bituminous material.

403.13 Seal Coat. When constructing A-2 or A-3, the seal coat shall not be started until the cover coat immediately preceding the seal coat is completed.

Application of the bituminous material and aggregate and rolling of the seal coat aggregate shall be the same as specified above in Article 403.12 for the cover coat.

During the construction period, the Contractor shall maintain the completed work. If necessary, the Contractor shall apply additional seal coat aggregate to absorb excess bitumen appearing on the surface and shall repair any areas where pickup has occurred.

Upon completion of the work, and after final set of the asphalt, excesses of loose aggregate shall be removed by brooming the entire roadway surface with rotary type brooms.

403.14 Opening to Traffic. The road shall be opened to traffic according to Article 701.05(c)(5).

403.15 Method of Measurement. Bituminous materials will be measured for payment as specified in Section 1009.

Cover Coat Aggregate and Seal Coat Aggregate will be measured in metric tons (tons) according to the requirements of Article 311.08(b), except that measurement for payment will not be made for aggregate in excess of 110 percent of the amount specified by the Engineer.

403.16 Basis of Payment. This work will be paid for at the contract unit prices per liter (gallon) for BITUMINOUS MATERIALS (PRIME COAT) and BITUMINOUS MATERIALS (COVER AND SEAL COATS) or at the contract unit prices per metric ton (ton) for BITUMINOUS MATERIALS (PRIME COAT) and BITUMINOUS MATERIALS (COVER AND SEAL COATS), and per metric ton (ton) for COVER COAT AGGREGATE and SEAL COAT AGGREGATE.

When provided as a payment item, the preparation of the base or existing surface will be measured and paid for as specified in Section 358. If not provided as a payment item, preparation of base or existing surface shall be considered as included

in the contract unit price(s) for the bituminous surface treatment, and no additional compensation will be allowed.

SECTION 404. BITUMINOUS SURFACE ROAD MIX (CLASS B)

404.01 Description. This work shall consist of constructing a bituminous surface consisting of a mixture of aggregates and bituminous material blended together by road mixing or a traveling plant on a prepared base. If required by the Special Provisions, a seal coat shall be applied to the bituminous surface.

404.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Aggregate	1004.03
(b) Seal Coat Aggregate	1004.03
(c) Bituminous Material (Note 1)	1009

Note 1. The Contractor may use any one of the types of bituminous materials as listed in the table below. When more than one grade is shown for a particular type, the Engineer reserves the right to specify the grade which shall be used.

Type of Construction		Bituminous Materials Recommended for Weather Conditions Indicated	
		Warm [15 °C to 30 °C]* [(60 °F to 85 °F)]*	Hot [30 °C Plus]* [(85 °F Plus)]*
Prime		MC-30, PEP	MC-30, PEP
Bituminous Surface Road Mix	With road grader or road mixer	MC-250, MC-800 SC-250, SC-800 MS-2, SS-1 CMS-2, CSS-1 HFE-150, HFE-300	MC-800 SC-800 MS-2, SS-1 CMS-2, CSS-1 HFE-150, HFE-300
	With Traveling Plant	MC-800 SC-800 MS-2, SS-1 CMS-2, CSS-1 HFE-150, HFE-300 RS-1, RS-2	MC-800 SC-800 MS-2, SS-1 CMS-2, CSS-1 HFE-150, HFE-300 RS-1, RS-2
Seal Coat when required by Special Provisions		RC-800, RC-3000, MC-800, MC-3000, SC-3000 CRS-1, CRS-2, HFE-90, HFE-150, HFE-300	RC-800, RC-3000 MC-3000 SC-3000 PG46-28, PG52-28 CRS-1, CRS-2, HFE-90, HFE-150 HFE-300

*Temperature of the air in the shade at the time of application.

404.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Three-Wheel Roller (Note 1)	1101.01
(b) Tandem Roller (Note 1)	1101.01
(c) Pneumatic-Tired Roller	1101.01
(d) Mechanical Sweeper	1101.03
(e) Traveling Plant.....	1102.02
(f) Aggregate Spreader	1102.04
(g) Pressure Distributor.....	1102.05
(h) Road Mixer	1102.06
(i) Heating Equipment.....	1102.07
(j) Drag.....	1102.08
(k) Windrow Evener.....	1102.09
(l) Grader	1102.10

Note 1. The three-wheel or tandem rollers shall weigh 5.5 to 9 metric tons (6 to 10 tons).

CONSTRUCTION REQUIREMENTS

404.04 General. This work shall be done only between May 1 and October 1. Bituminous materials shall be applied and bituminous mixtures shall be placed only when the temperature of the air in the shade is above 15 °C (60 °F). No work shall be started if local conditions indicate that rain is imminent.

Rolling of the bituminous mixture shall be done with a three-wheel or tandem roller.

All surfaces shall be cleaned of dirt, debris, and loose material prior to placing any bituminous material or bituminous mixture.

404.05 Sequence of Work. The construction operations shall be undertaken in the following sequence:

- (a) Repair and preparation of base.
- (b) Preparation and application of bituminous material for prime coat.
- (c) Proportioning and placing aggregate.
- (d) Preparation of bituminous mixture.
- (e) Spreading and rolling bituminous mixture.
- (f) Construction of seal coat, if required by Special Provisions.

404.06 Repair and Preparation of Base. The base shall be prepared according to Section 358.

404.07 Preparation and Application of Bituminous Material for Prime Coat. The bituminous material for prime coat shall be prepared according to Article 403.07 and applied according to Articles 403.09 and 403.11.

404.08 Proportioning and Placing of Aggregate. If the aggregate consists of a single graded aggregate within the limits specified, the Engineer will notify the Contractor as to the quantity of aggregate per station to be placed in the windrow.

If a single graded aggregate is used for the mixture, it shall be placed in a uniform windrow by means of an aggregate spreader.

If two or more gradations of aggregates are blended for the mixture, the Engineer will determine the proportions necessary to obtain an aggregate uniformly graded within the limits specified, and will notify the Contractor as to the quantity per station of each that shall be placed in the windrow.

If two or more gradations of aggregates are blended for the mixture, each gradation shall be placed in a uniform windrow with an aggregate spreader meeting the approval of the Engineer and then mixed thoroughly and placed in a windrow. If small quantities of aggregate are to be added to the windrow, and it is not feasible to use an aggregate spreader, they shall be placed by methods approved by the Engineer.

Aggregate shall not be hauled when the weather or road conditions are such that the hauling operations will cause cutting up or rutting of the base.

404.09 Preparation of Bituminous Mixture. The aggregate shall be relatively free of surface moisture. If necessary to reduce the moisture content, the aggregate shall be aerated by blading the aggregate back and forth across the base until the moisture content has been reduced to the satisfaction of the Engineer. Immediately before the application of the bituminous material, the aggregate shall be shaped with a windrow evener. The windrow evener shall be adjusted so that the windrowed aggregate will have the desired uniform cross section.

The aggregate and bituminous material shall be mixed with graders, road mixers, traveling plants, or other equipment approved by the Engineer. When graders are used, not less than two will be required for each 800 m (1/2 mile) or fraction thereof under preparation at one time.

The bituminous material used in the bituminous mixture shall be according to Article 404.02. Bituminous material shall be added to the aggregate at a rate of 3.5 to 5.5 percent by weight of total mixture; the percentage will be set by the Engineer. The percent of bituminous material shall be based upon the residual bitumen content.

The aggregate and bituminous material shall be mixed so that a homogeneous mixture is obtained in which all particles of the aggregate are coated uniformly.

- (a) **Grader and Road-Mixer Methods.** When graders or road mixers are used for mixing, the windrow of aggregate shall be flattened before applying the bituminous material. The bituminous material shall be applied by means of a pressure distributor. There shall be at least three applications of

bituminous material. The first application shall not exceed 1/2 of the total quantity required. In general, the mixing operations shall be carried on in the central portion of the base. The mixing operations shall not be closer than 450 mm (18 in.) to the edges of the existing or new base. When mixing has been carried on in such a manner that at the time of the second or subsequent application of bituminous material, the layer of mixed material is not uniform in cross section, the mixed material shall be reshaped to a uniform cross section by means of a windrow evener or other equipment approved by the Engineer, so that the bituminous material is applied to the mixed material at a uniform rate.

When graders are used for mixing, the treated aggregate shall be given a preliminary mixing with either a spring-tooth harrow, a disk or a rotary speed mixer meeting the approval of the Engineer immediately after each application of bituminous material. After the preliminary mixing of the aggregate and bituminous material, the mixing shall be continued with graders. The windrow shall be moved from one side of the primed base to the other until the mixture is free from lumps, homogeneous, and of uniform color. When longitudinal drifting of material occurs, the direction of mixing operations shall be varied, or other methods used, so as to obtain a windrow of uniform cross section.

When road mixers are used for mixing, the treated aggregate shall be mixed after each application of bituminous material. Mixing shall be continued until the mixture is free from lumps, homogeneous, and of uniform color. When the total amount of aggregate necessary to construct the surface to the specified width and depth cannot be mixed at one time, it shall be mixed in portions and the mixed portions placed in a windrow on one side of the base; in which case, after mixing is completed with the road mixer, the total mixed material shall be mixed and blended with a grader until it is uniform in color, consistency and gradation.

The mixing shall be performed in such a manner as to prevent segregation of the various aggregate sizes or loss of the fine aggregate, and to agitate the entire mixture but not disturb the base. The mixture shall be kept within the limits of the base, and no earth or other foreign matter shall be permitted in the mixture. When the work is more than 1600 m (1 mile) in length, the train of mixing equipment shall travel at least 800 m (1/2 mile) before turning around.

If, after mixing, it is the Engineer's decision that the mixture does not contain the proper amount of bituminous material, more bituminous material or aggregate shall be added according to the Engineer's directions, and mixing continued until the bituminous mixture is homogeneous and uniform in color. After the bituminous mixture has been prepared as required, it shall be windrowed on one side of the prepared base. The windrow shall be uniform in size.

- (b) Traveling-Plant Method. When traveling plants are used for mixing, the amount of bituminous material applied will be designated by the Engineer and may be adjusted by the Engineer as the work progresses. Material which may fall outside, or which is not picked up by the conveyor, shall be

picked up by hand labor and thrown directly into the elevating unit and onto the windrow ahead. The application of bituminous material shall be made in such a manner that the resulting mixture will be homogeneous and uniform in color.

The use of a windrow evener may be omitted when mixing is done with a traveling plant. The feed control of the traveling plant will be calibrated and set by the Engineer.

If one operation of the traveling plant does not produce a uniform bituminous mixture, the windrow shall be remixed with the traveling plant, grader, road mixer or by other methods approved by the Engineer, until the bituminous mixture is uniform in texture and color. If the mixture does not contain the proper amount of bituminous material, additional bituminous material or aggregate shall be added and the windrow remixed as specified herein.

404.10 Spreading of Bituminous Mixture. After the mixture has been prepared, windrowed, and cured, it shall be divided into two equal parts with motor graders having end plates attached to the blades. One part shall be bladed across the centerline and spread uniformly upon that portion of the base. The remaining portion of the windrow shall be spread uniformly upon the other portion of the base. Spreading shall be done so segregation shall be kept to a minimum, and the finished surface will be smooth and of uniform texture. The mixture shall be spread to a true line along the edges of the pavement. Care shall be taken to smooth out junctions of successive operations.

If, after spreading the mixture, there are any portions which are not homogeneous, do not contain sufficient bituminous material, or contain an excess of bituminous material, such portions shall be corrected as directed by the Engineer.

Unless the mixture can be spread to the final cross section and rolled the same day as mixed, it shall be left in the windrow. Should rain fall during road-mixing operations, or after the mixture has been spread and before it has been rolled, the mixture shall be windrowed and not disturbed until the base contains no visible moisture. The mixture shall then be bladed back and forth across the base until the moisture in the mixture has been removed to the satisfaction of the Engineer.

404.11 Compaction of Bituminous Mixture. After the mixture has been spread and when it will bear the weight of the roller without excess lateral movement, it shall be rolled longitudinally. Rolling shall start at the edges and progress toward the center, overlapping on successive trips by at least 1/2 the width of the roller. The entire surface shall be rolled twice in this manner, unless in the opinion of the Engineer, additional rolling is necessary. Final rolling shall be accomplished by one passage of the roller along each edge of the pavement. The edges shall be compacted to form an angle of approximately 45 degrees with the surface of the bituminous mixture.

All roller wheels shall be moistened lightly with water to prevent bituminous material from sticking to them. If the bituminous surface has absorbed moisture before rolling is completed, it shall be torn up, bladed back and forth across the base until dry and then relaid at the Contractor's expense. When the rolling has been completed and the surface has cured, traffic may be allowed upon it.

404.12 Surface Tests. After the bituminous mixture has been compacted, the surface will be tested for smoothness by means of a 5 m (16 ft) straightedge placed parallel to the centerline of the pavement, parallel to the grade line in each wheel lane and touching the surface. Ordinates measured from the face of the straightedge to the surface of the pavement shall at no place exceed 10 mm (3/8 in.). If the variation from a true surface exceeds 10 mm (3/8 in.), the entire area so affected shall be corrected as approved by the Engineer.

404.13 Seal Coat. When specified, seal coat shall be constructed according to the requirements of Articles 403.07, 403.08, 403.09, 403.10 and 403.13. The seal coat shall not be applied until the bituminous mixture has been subjected to traffic for a period of not less than four weeks. The surface shall be swept clean, removing all dirt, debris, and loose material. It shall be clean and dry when the bituminous material is applied.

404.14 Opening to Traffic. The road shall be opened to traffic according to Article 701.05(c)(6).

404.15 Method of Measurement. Bituminous material will be measured as specified in Section 1009.

Aggregate and Seal Coat Aggregate will be measured for payment in metric tons (tons) according to Article 311.08(b), except measurement for payment will not be made for seal coat aggregate in excess of 110 percent of the amount specified by the Engineer.

404.16 Basis of Payment. This work will be paid for at the contract unit prices per liter (gallon) for BITUMINOUS MATERIALS (PRIME COAT), BITUMINOUS MATERIALS (ROAD MIX) and BITUMINOUS MATERIALS (SEAL COAT) or per metric ton (ton) for BITUMINOUS MATERIALS (PRIME COAT), BITUMINOUS MATERIALS (ROAD MIX) and BITUMINOUS MATERIALS (SEAL COAT), and per metric ton (ton) for AGGREGATE and SEAL COAT AGGREGATE.

If provided as a payment item, the repair and preparation of the base will be measured and paid for as specified in Section 358. If not provided as a payment item, repair and preparation of base shall be considered as included in the contract unit price for the bituminous surface, and no additional compensation will be allowed.

SECTION 405. BITUMINOUS SURFACE PLANT MIX (CLASS B)

405.01 Description. This work shall consist of constructing one or more courses of a mixture of aggregates and bituminous material on a prepared base.

405.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000:

Item	Article/Section
(a) Aggregate	1004.03
(b) RAP Material (Note 1)	1004.07
(c) Bituminous Materials (Note 2)	1009

Note 1. The original pavement or hot mix bituminous materials need not contain crushed coarse aggregate.

Note 2. The particular type and grade of bituminous material to be used will be specified in the contract. The Contractor may use any one of the types of bituminous materials listed in the table below. When more than one grade is shown for a particular type, the Engineer reserves the right to specify the grade which shall be used.

Type of Construction	Bituminous Materials Recommended
Prime	MC-30
Bituminous Surface Plant Mix (Note 1)	SC-800, SC-3000 MC-3000 PG52-28, PG58-28, PG58-22

Note 1. When RAP material is used in the mixture, the bituminous material shall be PG46-28, PG52-28, PG58-28 or PG58-22.

405.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Self-propelled Pneumatic-Tired Roller (Note 1)	1101.01
(b) Three-Wheel Roller (Note 2)	1101.01
(c) Tandem Roller (Note 2)	1101.01
(d) Pneumatic-Tired Roller	1101.01
(e) Mechanical Sweeper	1101.03
(f) Heating Equipment	1102.07
(g) Pressure Distributor	1102.05
(h) Drier.....	1102.01
(i) Pugmill-Mixer.....	1102.01
(j) Continuous Mixer.....	1102.01
(k) Temperature Recording Instrument.....	1102.01
(l) Spreading and Finishing Machine.....	1102.03
(m) Hot-Mix Surge Bins	1102.01
(n) Drier Drum Hot-Mix Plant (Note 3)	1102.01
(o) Vibratory Roller (Note 4)	1101.01

Note 1. The self-propelled pneumatic-tired roller shall develop a compression of not less than 53 N/mm (300 lb/in.) nor more than 88 N/mm (500 lb/in.) width of tire tread in contact with the bituminous surface. The tires shall be inflated to an air pressure of not less than 415 kPa (60 psi). When the tires are operating in a hot condition and there is no tire pickup, the water system may be turned off.

Note 2. The three-wheel or tandem rollers shall weigh 5.5 to 9 metric tons (6 to 10 tons) and develop a unit compression on the compression wheels of not less than 35 N/mm (200 lb/in.) nor more than 61 N/mm (350 lb/in.) of wheel width.

Note 3. When a drier-drum hot-mix plant is used to produce Class B surface mixture incorporating RAP material, the plant shall be suitably modified to produce recycled bituminous mixes in a manner approved by the Engineer.

Note 4. The vibratory roller shall develop a total applied force of not less than 35 N/mm (200 lb/in.) nor more than 61 N/mm (350 lb/in.).

CONSTRUCTION REQUIREMENTS

405.04 General. The bituminous mixture shall be constructed only on a dry base under the following conditions unless otherwise authorized in writing by the Engineer:

(a) When slow curing asphalts are used;

(1) Between May 1 and October 1, and

(2) The air temperature in the shade is above 10 °C (50 °F).

(b) When medium curing asphalt is used;

(1) Between May 1 and October 15, and

(2) The air temperature in the shade is above 5 °C (40 °F).

(c) When asphalt cements are used, the air temperature in the shade is above 5 °C (40 °F).

No work shall be started if local conditions indicate rain is imminent.

When the aggregate for the bituminous mixture consists of a single graded aggregate, the Contractor shall unload the graded aggregate into the stockpile and shall use only the graded aggregate from the stockpile. In addition, the Contractor shall have available fine or coarse aggregate to be blended with the graded aggregate to the satisfaction of the Engineer when it is necessary to correct nonuniformity in the gradation of the graded aggregate.

If approved by the Engineer, separate sizes of aggregates may be blended to produce the bituminous mixture. The method of blending shall be by the use of aggregate feeders of the apron, drum, reciprocating, or other type approved by the Engineer, which shall provide for proportional and total feeding of the aggregates. The components of the blend need not be of the same source or of the same kind of material.

The sources of material shall not be changed during the progress of the work without written permission from the Engineer. All surfaces shall be cleaned of dirt, debris and loose material prior to placing any bituminous material or bituminous mixture.

405.05 Sequence of Work. The construction operations shall be undertaken in the following sequence:

- (a) Repair and preparation of base.
- (b) Preparation and application of bituminous material for prime coat.
- (c) Preparing, transporting, spreading, and rolling bituminous mixture.

405.06 Repair and Preparation of Base. The base shall be prepared according to Section 358.

405.07 Preparation and Application of Bituminous Materials. The bituminous material for prime coat shall be prepared according to Article 403.07 and shall be applied according to Articles 403.09 and 403.11.

The bituminous material for the mixture shall be transferred to the asphalt tanks and heated to the temperatures as follows:

Type of Bituminous Material	Temperature	
	Minimum	Maximum
Slow Curing Liquid Asphalts	Workable	Not to exceed Flash Point or 135 °C (275 °F)
Medium Curing Liquid Asphalts	Workable	Flash Point
Asphalt Cements	105 °C (225 °F)	165 °C (325 °F)

405.08 Preparation of Bituminous Mixture. The aggregates for the bituminous mixture shall be dried and heated in the revolving drier according to the following table when equipment meeting the requirements of Article 1102.01(a) through (d) is used. When a plant meeting the requirements of Article 1102.01(e) is used, the bituminous material shall be asphalt cement with a minimum temperature of 95 °C (200 °F) and there will be no limitations on moisture of the aggregates.

Bituminous Material	SC	MC	AC
Maximum Moisture	0.5%	1.0%	
Minimum Temperature	95 °C (200 °F)	---	120 °C (250 °F)
Maximum Temperature	135 °C (275 °F)	105 °C (225 °F)	165 °C (325 °F)

The aggregate and bituminous material used in the mixture shall be measured separately and accurately by weight or by volume. The devices used in weighing or measuring the aggregate and bituminous material shall be of a type approved by the Engineer. When the aggregate is in the mixer, the bituminous material shall be added and mixing continued until a homogeneous mixture is produced in which all the particles of the aggregate are coated uniformly. The mixing time will be determined by the Engineer.

The ingredients shall be heated and combined in such a manner and at such a temperature as to produce a mixture which when discharged from the mixer, will not in general, vary more than 10 °C (20 °F) from the temperature set by the Engineer. The temperature of the bituminous mixture shall not be more than the maximum temperature noted in the above table for the bituminous material being used. The bituminous mixture shall conform to the following composition limits by weight:

Aggregate 94.0 to 96.5%
 Bituminous Material 3.5 to 6.0%

The percentage of bituminous material will be determined by the Engineer. The percentage of bituminous material shall be based upon the residual bitumen content. The percentage of residual bitumen shall be controlled within ± 0.5 percentage points of the percentage set by the Engineer. The right is reserved to make such changes in the proportions of bituminous material and aggregates as the Engineer may consider necessary within the limits of the specifications.

405.09 Preparation of Bituminous Mixture Using RAP. When RAP materials are being used, the RAP material(s), virgin aggregate(s) and asphalt cement shall be proportioned within the following composition limits by weight:

<u>Ingredient</u>	<u>Percent by Dry Weight</u>
Virgin Aggregate(s)	46-93
RAP Material(s)	0-50
Mineral Filler (if required)	0-5
Bituminous Material	4.0-7.0

The virgin aggregates shall be dried and heated in the drier to a temperature that will produce the specified resultant mix temperature when combined with the RAP material.

The heated virgin aggregates and mineral filler shall be combined with the RAP material in such a manner as to produce a bituminous mixture which when discharged from the mixer shall not vary more than 15 °C (30 °F) from the temperature set by the Engineer. The combined ingredients shall be mixed for a minimum of 30 seconds or until a homogeneous mixture as to composition and temperature is obtained. For a batch type plant, the standard 15 seconds dry and 30 seconds wet mixing time should normally be used. Variation in wet and dry mixing times may be permitted, depending on the moisture content and amount of RAP material used. The mix temperature shall not exceed 180 °C (350 °F). Wide variations in the mixture temperature will be cause for rejection of the mix.

The final mixture(s) shall conform to the following Standard Deviations. These deviations will be verified by extraction tests of the final mixture. If these stipulations are not met, the amount of RAP material used shall be reduced by ten percent increments per day until mix is produced meeting these requirements. When the Contractor is able to produce mixtures within these criteria for three consecutive days, the percent of RAP material may again be increased.

<u>Selected Criteria (CA-6)</u>	<u>Standard Deviation 1/</u>	<u>Tolerance 2/</u>
Passing 25 mm (1 in.) sieve	5.0	90 - 100
Passing 12.5 mm (1/2 in.) sieve	6.5	60 - 90
Passing 4.75 mm (No. 4) sieve	5.5	30 - 56
Passing 1.18 mm (No. 16) sieve	4.5	10 - 40
Passing 75 µm (No. 200) sieve	2.5	4 - 12
Passing 75 µm (No. 200) sieve	2.5	4 - 12
Bitumen	0.5	3 - 7

<u>Selected Criteria (CA-10)</u>	<u>Standard Deviation 1/</u>	<u>Tolerance 2/</u>
Passing 25 mm (1 in.) sieve		100
Passing 12.5 mm (1/2 in.) sieve	6.5	65 - 95
Passing 4.75 mm (No. 4) sieve	6.0	40 - 60
Passing 1.18 mm (No. 16) sieve	5.0	15 - 45
Passing 75 µm (No. 200) sieve	2.5	5 - 13
Bitumen	0.5	3 - 7

<u>Selected Criteria (CA-12)</u>	<u>Standard Deviation 1/</u>	<u>Tolerance 2/</u>
Passing 12.5 mm (1/2 in.) sieve	5.0	90 - 100
Passing 9.5 mm (3/8 in.) sieve	4.0	75 - 95
Passing 4.75 mm (No. 4) sieve	5.0	50 - 70
Passing 1.18 mm (No. 16) sieve	4.5	25 - 45
Passing 75 µm (No. 200) sieve	2.5	5 - 13
Bitumen	0.5	3 - 7

1/ - Represents the Standard Deviation of the overall population.

2/ - Individual tests shall be between these tolerances.

The percentage of bituminous material will be determined by the Engineer. The percent of bituminous material shall be based upon the residual bitumen content. The percentage of residual bitumen shall be controlled within ± 0.5 percent of the percent set by the Engineer. The right is reserved to make such changes in the proportions of bituminous material and aggregates as the Engineer may consider necessary within the limits of the Specifications.

405.10 Transportation. Vehicles used in transporting the bituminous mixtures shall have tight dump bodies which have been previously cleaned of all foreign material and sprayed with asphalt release agents. The beds shall be sprayed with asphalt release agents which have been tested and approved by the Department. After spraying, the bed of the vehicle shall be in a completely raised position and shall remain in this position until all excess release agent has been drained. When the air temperature is below 15 °C (60 °F), vehicle bodies including the end, endgate, sides and bottom shall be insulated with fiberboard, plywood or other approved insulating material and shall have a thickness of not less than 20 mm (3/4 in.). When the insulation is placed inside the vehicle body, the insulation shall be covered with sheet steel approved by the Engineer. Each vehicle shall be equipped with a cover of canvas or other suitable material meeting the approval of the Engineer which shall be used if any one of the following conditions are present:

- (a) Ambient air temperature is below 15 °C (60 °F).
- (b) The weather is inclement.
- (c) When asphalt cement is used, the temperature of the bituminous mixture immediately behind the paver screed is below 105 °C (225 °F).

The cover shall extend down over the sides and ends of the truck for a distance of 300 mm (12 in.) and shall be fastened securely. Bituminous mixture which cannot be spread and compacted during daylight shall not be sent to the work unless artificial light satisfactory to the Engineer is provided. The bituminous mixture shall not be hauled when the weather or road conditions are such that the hauling operations will cause cutting up or rutting of the base, or the tracking of mud on the primed base or partially completed work.

405.11 Spreading. The temperature of the bituminous mixtures delivered shall be according to the following table when a batch, continuous or dryer drum plant for Class I mixes is used. When a dryer drum plant for other than Class I mixes is used, the minimum temperature shall be 90 °C (200 °F).

Bituminous Material	Temperature	
	Minimum	Maximum
SC	80 °C (175 °F)	135 °C (275 °F)
MC	Workable	105 °C (225 °F)
AC	105 °C (225 °F)	160 °C (325 °F)

The bituminous mixtures shall be placed with a spreading and finishing machine to the typical cross section shown on the plans. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked and luted by hand tools. Where the specified thickness of the finished compacted surface is greater than 50 mm (2 in.), the bituminous mixture shall be spread and compacted in two or more layers. When the bituminous mixtures are placed in partial widths, the individual widths of the top layer shall conform to the traffic lanes.

The spreading and finishing machine shall be operated at a speed that will ensure, as near as possible, continuous operation. The operating speed will be approved by the Engineer. A string line shall be used as a guide for the finishing machine in order to maintain uniform edge alignment; if any other method is proposed, it shall meet the approval of the Engineer before being used. Irregularities in the alignment of the outside edges shall be corrected by adding or removing bituminous mixture before the edges are rolled. In spreading the bituminous mixture, care shall be taken to prevent any damage to the prime coat. The bituminous mixture shall be placed away from a transverse joint.

405.12 Joints. Contact surfaces of curbs, gutters, manholes, and similar structures shall be painted with a thin uniform coating of Asphalt: RC-70; just before the bituminous mixture is placed against them. The mixture shall be placed uniformly high, so after compaction it will be 6 mm (1/4 in.) above the edges of such structures.

Joints between old and new pavements or between successive days' work shall be made to ensure thorough and continuous bond between the old and new mixtures.

Transverse construction joints in previously laid material may be constructed by cutting the material back for its full depth to expose a fresh surface. Where a wooden header is used at a construction joint, the cutting may be omitted provided the joint conforms to the specified thickness. Before placing the fresh mixture against a cut joint or against old pavement, the contact surface shall be sprayed or painted with a thin, uniform coating of Asphalt: RC-70.

Bituminous material for painting joints shall be considered as included in the cost of the work and no additional compensation will be allowed.

Surfacing at intersections, alley returns and driveways may be constructed simultaneously with the adjacent areas.

405.13 Compaction. After the bituminous mixture has been spread as required, it shall be rolled and compacted thoroughly and uniformly with a three-wheel, tandem, or vibratory roller. Where initial rolling causes undue displacement, hair cracking, or checking of the bituminous mixture, the time of the rolling shall be adjusted as directed by the Engineer.

One three-wheel, tandem or vibratory roller will be required where the average placement at the jobsite is 75 metric tons (85 tons) per hour or less. Two steel wheel rollers either three-wheel, tandem or vibratory, will be required when the average placement at the jobsite is more than 75 metric tons (85 tons) per hour. A self-

propelled pneumatic roller may be used in lieu of a steel wheel roller for breakdown rolling followed by a steel wheel roller for finishing when approved by the Engineer.

Rolling of the first lane of bituminous mixture to be placed shall start longitudinally at the edge having the lower elevation and progress to the other edge, overlapping uniformly on successive trips by at least 1/2 the width of the compression wheels. Where laying the bituminous mixture adjacent to a previously placed lane, the first pass of the roller shall be along the longitudinal joint in such a manner that not more than 1/3 the width of the compaction wheel is on the freshly placed mixture; after which the rolling shall proceed from the outside edge toward the longitudinal joint, overlapping uniformly on successive trips by at least 1/2 the width of the compression wheels.

When the roller or rollers as required for plant production cannot make two coverages each, of the rolling pattern specified above, an additional roller shall be furnished when requested by the Engineer. Final rolling of the last course of bituminous material shall be accomplished by one passage of the roller along each edge of the pavement. All roller wheels shall be moistened lightly to prevent bituminous material from sticking to the wheels. When the rolling has been completed, and the surface of the bituminous mixture has hardened or cured to the satisfaction of the Engineer, traffic may be allowed upon it.

405.14 Surface Tests. After the bituminous mixture has been compacted, the surface shall be tested for smoothness by means of a 5 m (16 ft) straightedge placed parallel to the centerline of the pavement, parallel to the grade line in each wheel lane and touching the surface. If the ordinates measured from the surface of the straightedge to the surface of the pavement exceed 10 mm (3/8 in.), the entire area so affected shall be corrected as approved by the Engineer.

405.15 Method of Measurement. Bituminous material for prime coat will be measured according to Section 1009. The unit of measurement will be as shown on the plans.

Bituminous Mixture will be measured in metric tons (tons). The Contractor shall furnish or arrange for the use of scales of a type approved by the Engineer to measure loaded trucks.

Bituminous Mixture produced by a continuous-type mixing plant shall be weighed on approved platform scales furnished by the Contractor. Bituminous Mixture produced by a batch-type mixing plant may be measured by either weighing the mixture on approved platform scales or on the basis of plant weights. If measured on the basis of plant weights, an occasional check shall be made by weighing full truckloads of the mixture on an approved scale at the plant or on an approved commercial scale. If, during the course of construction, it becomes apparent that the weigher on the mixer platform or the weigher at the platform scale is not exercising proper care in weighing the bituminous mixture, the weigher shall be removed at the direction of the Engineer and replaced by a competent and qualified worker. Quantities of materials wasted or disposed of in a manner not called for in the contract will be deducted from the final total measured quantities. The Contractor shall furnish a load ticket (duplicate tickets if required) upon which is recorded the net weight of the bituminous mixture in each truck. The ticket shall have sufficient space for signatures, identification of the mixture, date of delivery, and any other data which

the Engineer may require. The Contractor shall submit the load ticket to the Engineer at the work when the truck arrives.

Measurement for payment will not be made for bituminous mixture in excess of 103 percent of the amount specified by the Engineer.

405.16 Basis of Payment. This work will be paid for at the contract unit prices per liter (gallon) for BITUMINOUS MATERIALS (PRIME COAT) or per metric ton (ton) for BITUMINOUS MATERIALS (PRIME COAT) and per metric ton (ton) for BITUMINOUS MIXTURE COMPLETE.

If provided as a payment item, the repair and preparation of the base will be measured and paid for as specified in Section 358. If not provided as a payment item, repair and preparation of the base shall be considered as included in the contract unit price for the bituminous surface, and no additional compensation will be allowed.

SECTION 406. BITUMINOUS CONCRETE BINDER AND SURFACE COURSE CLASS I

406.01 Description. This work shall consist of constructing one or more bituminous concrete binder courses and a bituminous concrete surface course on a prepared base.

406.02 Materials. Materials shall meet the following requirements of Section 1000 - Materials:

Item	Article/Section
(a) Coarse Aggregate	1004.03
(b) Fine Aggregate	1003.03
(c) RAP Material	1004.07
(d) Mineral Filler	1010.04, 1011
(e) Hydrated Lime	1012.01
(f) Slaked Quicklime (Note 1)	
(g) Bituminous Material (Note 2)	1009

Note 1. Slaked quicklime shall conform to the requirements of ASTM C 5.

Note 2. The Contractor shall use any one of the types of bituminous materials listed in the table below. When more than one grade is shown for a particular type, the Engineer reserves the right to specify the grade which shall be used. The asphalt cement grade for Binder and Surface Course will be selected by the Engineer and shown on the plans.

Type of Construction	Bituminous Materials
Prime (tack) on Brick Concrete or Bituminous Bases (Note 3)	SS-1, SS-1h, CSS-1, CSS-1h HFE 60, HFE 90, RC-70
Prime on Aggregate Bases	MC-30
Mixture for Cracks, Joints and Flangeways	PG58-22, PG64-22

Art. 406.03 Bituminous Concrete Binder And Surface Course Class I

Note 3. When emulsified asphalts are used, they shall be diluted with an equal volume of potable water. HFE emulsions shall be diluted by the manufacturer. The diluted material shall be thoroughly agitated within 24 hours of application and show no separation of water and emulsion. The diluted material shall not be returned to an approved emulsion storage tank.

406.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment except as modified by the Equipment Definitions of Article 406.16:

Item	Article/Section
(a) Self-propelled Pneumatic-Tired Roller	1101.01
(b) Three-Wheel Roller	1101.01
(c) Tandem Roller	1101.01
(d) Vibratory Roller	1101.01
(e) Hot-Mix Plant (Note 1)	1102.01
(f) Spreading and Finishing Machine	1102.03
(g) Pressure Distributor	1102.05
(h) Heating Equipment	1102.07
(i) Trench Roller	1101.01
(j) Hot-Mix Surge Bins	1102.01
(k) Pavement Surface Test Equipment	1101.10(a).

Note 1. When a drier-drum hot-mix plant is used to produce Class I mixtures incorporating RAP material, the plant shall be suitably modified to produce recycled bituminous mixes in a manner approved by the Engineer.

CONSTRUCTION REQUIREMENTS

406.04 General. The leveling binder, binder and surface course mixtures shall be placed on a dry base and when weather conditions are suitable. In the event of sudden rain, loading additional trucks shall immediately stop whether it be from the plant or storage bins. Material in transit will be permitted to be laid at the Contractor's risk providing the pavement is free of standing water and the proper temperature of the asphaltic mix is maintained. Approval to unload the trucks in transit shall in no way relax the requirements for quality, density or smoothness of the bituminous mixture being placed.

The leveling binder and binder courses shall be placed only when the temperature in the shade is at least 5 °C (40 °F) and the forecast is for rising temperatures. The surface course shall be placed only when the air temperature in the shade is at least 8 °C (45 °F) and the forecast is for rising temperatures.

Mixture use shall be as follows:

Use	Type	Mixtures
Leveling Binder	1	B or C
	2 & 3	A, B, or C
Binder Course	1	B
	2 & 3	A or B
Surface Course	1 & 2	C, D or E
	3	C

In addition to the requirements listed above, the mixture for leveling binder shall be further modified as follows, depending upon the nominal thickness being placed:

Nominal Leveling Binder Thickness, mm (in.)	Mixture
Under 32 (1 1/4)	C with CA 16
32 (1 1/4)	C with CA 13 or CA 16
38 (1 1/2)	B or any of the above
Over 38 (1 1/2)	A or any of the above

The specific type and mixture to be used for leveling binder, binder course and surface course shall be as shown on the plans.

The Contractor shall furnish samples of the mixture at the place of manufacture or samples cut from the completed work when required by the Engineer for testing purposes. The areas of pavement so removed shall be replaced with new mixture and refinished. Furnishing test samples and replacing the areas with new material shall be considered as included in the cost of the item of construction involved, and no additional compensation will be allowed.

All surfaces shall be cleaned of dirt, debris and loose material prior to placing any bituminous material or bituminous mixture.

406.05 Keeping Road Open to Traffic. The road shall be kept open to traffic according to Article 701.05(c)(3).

406.06 Preparation, Priming and Leveling of Brick, Concrete or Bituminous Bases.

- (a) Preparation. When an existing pavement is used as a base, all excess crack filler and bituminous patches which contain an excess of bitumen or which are unstable in hot weather shall be removed. All bitumen shall be removed from expansion joints and cracks more than 40 mm (1 1/2 in.) wide. The Contractor shall perform this work in the most economical manner practicable and as directed by the Engineer. All waste material placed on the shoulders during the pavement cleaning operations shall be removed at the close of each day's work and shall be disposed of outside the limits of the right of way at locations acceptable to the Engineer.

Art. 406.06 Bituminous Concrete Binder And Surface Course Class I

Prior to placing leveling binder or binder course mixtures for multiple course construction and prior to placing surface course mixture for single course construction, all open cracks and open expansion joints having a width of 13 mm (1/2 in.) or more, expansion joints and cracks that have been cleaned, and street car track flangeways shall be filled completely with Mixture for Cracks, Joints and Flangeways. The mixture shall be hand tamped in place with hand tools.

- (b) Prime Coat. Before placing the bituminous mixture, the base, or base and gutter shall be cleaned of all dust, dirt, and foreign material and with dry existing conditions, the bituminous material, as specified for prime in Article 406.02, shall be applied uniformly at the rate of 0.2 to 0.5 L/sq m (0.05 to 0.10 gal/sq yd). The exact rate to be specified by the Engineer. The temperature in the shade shall be 15 °C (60 °F) or higher at time of application when emulsified asphalt is used. The bituminous priming material shall be prepared according to Article 403.07. The method of applying the bituminous priming material shall be according to Article 403.09.

The removal and disposal of dust, dirt, and foreign material from the area to be primed shall be included in the cost of the bituminous concrete item involved, and no extra compensation will be allowed for performing this work.

Where the road is to be kept open to traffic, the prime coat (except emulsion type) shall be placed not less than one hour in advance of the place of bituminous concrete and no prime coat shall be placed more than five days in advance of the placement of bituminous concrete.

Bituminous concrete may be placed over emulsified asphalt primer when the emulsion has broken and all free moisture has evaporated or drained off the surface. When an emulsified asphalt prime is used, the area to be primed shall be limited to that which can be covered with bituminous concrete the same day, unless otherwise permitted by the Engineer.

When directed by the Engineer, the prime coat shall be covered immediately following its application with fine aggregate mechanically spread at a uniform rate of 1 to 2 kg/sq m (2 to 4 lb/sq yd). The pavement shall be primed one lane at a time. The lane shall remain closed until the aggregate will not pickup under traffic. On multi-lane pavements, traffic will not be allowed on the primed surface and the traffic control shall be according to Article 701.06(f)(2). In all instances, the priming operation shall be performed in such a manner that a minimum amount of interference will be caused to traffic.

Where the road is closed to thru traffic, non-emulsion type prime may be placed no more than five days in advance of the placement of bituminous concrete. The prime coat need not be covered with fine aggregate. At least one lane shall remain unprimed until the prime coat on the adjacent pavement has cured sufficiently and will not pick up under traffic.

- (c) Leveling Binder. All depressions of 25 mm (1 in.) or more in the surface of the existing pavement will be filled with leveling binder. The Engineer will specify during construction which method of leveling binder placement shall be used.

Leveling binder placed with a finishing machine will be designated as Leveling Binder (Machine Method).

When placing leveling binder, the finishing machine shall be operated at a speed that shall ensure, as near as possible, continuous operation. The operating speed of the finishing machine shall be coordinated with the plant production and delivery of material for continuous operation. If the finishing machine is equipped with tamper bars, their use will not be required when the average amount of leveling binder being placed is less than 40 kg/sq m (70 lb/sq yd).

Where areas to be leveled are greater than 50 mm (2 in.) in depth, the leveling binder shall be placed and compacted in layers not exceeding a maximum depth of 50 mm (2 in.). The total thickness of leveling binder placed in one day will be limited to 100 mm (4 in.) unless otherwise directed by the Engineer. The leveling binder shall be placed at least 24 hours prior to placing the binder course. Leveling binder shall be compacted according to and meet the density requirements of Article 406.16.

Leveling binder placed other than with a finishing machine will be designated as Leveling Binder (Hand Method). Leveling Binder (Hand Method) shall be compacted with a roller to the satisfaction of the Engineer. Hand tamping will be permitted when approved by the Engineer.

At locations where heavy disintegration and deep spalling exists, the area shall be cleaned of all loose and unsound material with pneumatic tools, or other approved equipment, primed and filled with leveling binder. The cost of removal of all loose and unsound material will be paid for according to Article 109.04. The leveling binder used in these areas will be measured and paid for as specified for Leveling Binder (Hand Method).

406.07 Preparation and Priming of Aggregate Bases.

- (a) Preparation. The base shall be prepared according to Section 358.
- (b) Prime Coat. After the base has been prepared, and when in a dry condition, the bituminous material, as specified for prime in Article 406.02, shall be applied uniformly at the rate of 1 to 2 L/sq m (0.25 to 0.50 gal/sq yd), the exact rate to be specified by the Engineer. The bituminous priming material shall be prepared according to Article 403.07 and the method of application shall be as specified in Article 403.09.

The bituminous priming material shall be applied to the full width of the base course. The prime coat shall be permitted to cure until the penetration has been approved by the Engineer, but at no time shall the curing period be less than 24 hours. Pools of bituminous material occurring in the depressions shall be broomed or squeegeed over the surrounding surface

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the same day the prime coat is applied. Immediately after the application of prime coat, it shall be covered with fine aggregate mechanically spread at a uniform rate of 2 to 3 kg/sq m (4 to 6 lb/sq yd) as directed by the Engineer. The base shall be primed 1/2 width at a time. The prime coat on the second half-width shall not be applied until the prime coat on the first half-width has cured so that it will not pickup under traffic. In all instances, the priming operations shall be performed in such a manner that a minimum amount of interference will be caused to traffic.

When the road is closed to traffic, the bituminous prime coat material need not be covered with fine aggregate.

406.08 Preparation of Asphalt Cement. The asphalt cement shall be transferred to the asphalt tanks and brought to a temperature of 120 °C to 180 °C (250 °F to 350 °F).

406.09 Preparation of Mineral Aggregates. When a blend of two or more aggregates, meeting the specifications, is required, it shall be produced by the use of a cold aggregate feeder for each aggregate required. When the proportioning gates of the aggregate feeder are once set for proper blending, they shall be locked or bolted securely and their positions shall not be changed unless directed by the Engineer. If any of the aggregates used in preparing the mixture become intermixed in a bin compartment, the compartment shall be emptied and the intermixed material shall not be used.

The fine and coarse aggregates used in the bituminous mixtures shall be dried and heated in the revolving drier to a temperature of 120 °C to 180 °C (250 °F to 350 °F), such temperatures to be determined at the drier discharge. The fine and coarse aggregates for the bituminous mixtures may be fed simultaneously into the same drier. Immediately after heating, the binder course aggregates shall be screened into at least three sizes and the surface course aggregates into at least two sizes.

At the end of each day's run, the record sheet of the recording pyrometer or thermometer shall be turned over to and shall become a part of the records of the Engineer until the completion of the work.

During the drying process, the moisture content of the aggregate shall be reduced such that the moisture content of the bituminous mixture at time of discharge from the mixer will not exceed 0.5 percent. For certain aggregates such as air-cooled blast furnace slag, novaculite and other highly absorptive aggregates, special handling and treatment such as double drying may be required.

406.10 Designs, Mixing Formulas, and Tolerances.

- (a) Designs. The Class I binder and surface course mixtures shall be further classified as Type 1, Type 2, or Type 3 depending on the Marshall property requirements. Class I, Type 1, 2, and 3 Mixture designs shall be established by the Department or by the Contractor at his/her option. The Department will provide or verify no more than two mix designs per type of mix, per project, meeting established criteria.

- (1) Department Designs. The Contractor may request that the Department provide a mix design. The Contractor shall specify the blend of fine aggregate to be used. If the suggested blend does not result in a mix meeting all necessary criteria, the Department will provide a mix design using a fine aggregate blend it determines to be appropriate.

If the Department provided mix design is not satisfactory to the Contractor, he/she may elect to provide his/her own design as outlined in

The Contractor shall be responsible for prompt notification to the District Materials Engineer or local agency of proposed material sources so that sampling, and submittal of material to the Central Laboratory or local agency, may proceed in a timely manner. In no case will the mix design be initiated until the determination of the apparent low bidder.

- (2) Contractor's Designs. The Contractor may provide mix designs for each type of required mixture. Verification of the Contractor's mix design will be according to the Department's current policy Memorandum, "Bituminous Mixture Design Verification Procedure". The mix design shall be developed in a laboratory approved annually by the Department. The laboratory equipment shall meet the requirements set forth in the Department's current Stand Alone Document, "Bituminous Concrete Required Mix Design Laboratory Equipment". In no case will a mix design be verified until determination of the apparent low bidder.
- (b) Mixing Formula. Based on the data from the mixture designs and mixture criteria, mixing formulas will be established for each contract. The formulas will state definite percentages of aggregate on the sieve fractions and a definite percentage of bitumen.
- (c) RAP Designs. At the Contractor's option, Class I, Type 2 and 3, bituminous concrete binder, leveling binder or surface course (Mixture C) may be constructed utilizing RAP material.

When the Contractor chooses the RAP option for Class I, Type 2, the Contractor shall use the job mix formula as determined by the Department. For purposes of establishing the job mix formula, the Contractor shall furnish samples of the RAP coarse aggregate and fine aggregate to the Engineer at least four weeks prior to the start of production. The amount of RAP included in the mixture shall not exceed 25 percent for binder or 15 percent for surface.

When the Contractor chooses the RAP option for Class I, Type 3 mixtures, the requirements shall be the same as those for Class I, Type 2, except that the Contractor shall inform the Engineer of the desired amounts at the time he provides samples of the mix ingredients. The Engineer reserves the right to adjust the quantities of RAP material contained in the mixture for the purpose of mix design or field production, on the basis of test results.

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- (d) **Determination of Need for Anti-Stripping Additive.** The Department will determine during mixture design if an additive is needed in the mix to prevent stripping. The determination will be made on the basis of tests made according to the Department's accepted methods and procedures. To be considered acceptable by the Department as a mixture not susceptible to stripping, the ratio of conditioned to unconditional split tensile strengths (TSR) shall be equal to or greater than 0.75. Mixtures, with or without an additive, with TSR's less than 0.75 will be considered unacceptable.

If it is determined that an additive is required, the additive shall be hydrated lime, slaked quicklime or a liquid additive, at the Contractor's option. The liquid additive shall be selected from the Department's list of approved additives and may be limited to those which have exhibited satisfactory performance in similar mixes.

Dry hydrated lime shall be added at a rate of 1.0 to 1.5 percent by weight of total dry aggregate. Slurry shall be added in such quantity as to provide the required amount of hydrated lime solids by weight of total dry aggregate. The exact rate of application for all anti-stripping additives will be determined by the Department. The method of application shall be as specified in Article 406.12.

- (e) **Field Proportioning Tolerances.** For Class I, all mixtures shall closely conform to the formula as determined by hot-bin gradation analysis and will be verified by periodic extraction tests of the final mixture. The right is reserved, at any time during the progress of the work, to make such changes in the mixing formulas, including the percentage of RAP in the mixture, as the Engineer may consider necessary or desirable within the limits of the Specifications. During the progress of the work, the source of materials shall not be changed without prior approval in writing from the Engineer.

After the Engineer has established the job mix formula, the following tolerances will be permitted.

Job Mix Formula Tolerances		
	Binder Course Mixture	Surface Course Mixture
Retained 12.5 mm (1/2 in.) sieve	±6%	-
Passing 4.75 mm (No. 4) sieve	±5%	±5%
Passing 2.36 mm (No. 8) sieve	±5%	±5%
Passing 300 µm (No. 50) sieve	±4%	±4%
Passing 75 µm (No. 200) sieve (Note 1)	±1.5%	±1.5%
Bitumen (Note 1)	±0.3%	±0.3%

Note 1: Shall be determined by extraction test or by a calibrated nuclear asphalt gauge.

During production, the ratio of 75 μ m (No. 200) sieve material to asphalt shall be not less than 0.6 nor more than 1.2 and the moisture content of the mixture at discharge from the mixer shall not exceed 0.5 percent. If at any time, the ratio of 75 μ m (No. 200) sieve material to asphalt or the moisture content of the mixture falls outside the stated limits, production of mix shall cease. The cause shall be determined and corrective action satisfactory to the Engineer shall be initiated prior to resumption of production.

During production, mixture containing an anti-stripping additive will be tested for stripping by the Department's accepted methods and procedures. If the mixture fails to meet the TSR criteria for acceptance, no further mixture will be accepted until the Contractor takes such action as is necessary to furnish a mixture meeting the criteria.

406.11 Preparation of Mixture for Cracks, Joints and Flangeways. When the mixture is prepared in a batch-type mixing plant, the heated aggregate and the asphalt cement shall be measured separately and accurately by weight or by volume. The heated aggregate and asphalt cement shall be mixed in a pug mill mixer. When the aggregate is in the mixer, the asphalt cement shall be added and mixing continued until a homogeneous mixture is produced in which all particles of aggregate are coated uniformly. The mixing time will be determined by the Engineer.

When the mixture is prepared in a continuous-type mixing plant, the heated aggregate and asphalt cement shall be measured separately and accurately by volume. The heated aggregate and asphalt cement shall be mixed in the pug mill mixer for a period of time necessary to produce a homogeneous mixture in which all particles of aggregate are coated uniformly. The mixing time will be determined by the Engineer.

When the mixture is prepared in a drier drum plant, the heated aggregate and asphalt shall be accurately proportioned and mixed in the drier drum plant.

For all types of plants, the ingredients shall be combined in such proportions as to produce a mixture conforming to the following composition limits by weight:

Fine Aggregate (FA 1, FA 2 or FA 3)	93-96%
Bitumen	4-7%

With the permission of the Engineer, an approved cold-lay sand asphalt mixture may be used in lieu of the above mixture.

406.12 Preparation of Bituminous Mixtures.

(a) Batch-Type Plant.

When the bituminous mixture is prepared in a batch-type mixing plant, the heated aggregates, the mineral filler, and the asphalt cement shall be measured separately and accurately by weight or by volume. The heated aggregates and mineral filler shall be mixed in the pug mill mixer for a period

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of not less than ten seconds. The asphalt cement shall then be added and the mixing continued. The time required to add the asphalt cement shall be not more than 15 seconds. The total time required for adding the asphalt cement and completing the wet mixing period shall be not less than 35 seconds, or longer if necessary to produce a homogeneous mixture in which all particles of aggregate are coated uniformly. When the RAP option is used, the mix time for a batch type plant may vary in relation to the nature of the aggregate. The total mixing time shall be a minimum of 45 seconds consisting of dry and wet mixing. The times of dry and wet mixing shall be set by the Engineer. The same size batch weights shall be used in the production of bituminous mixtures, unless permission to change is granted in writing by the Engineer.

(b) Continuous-Type Plant.

When the bituminous mixture is prepared in a continuous-type mixing plant, the heated aggregates, mineral filler and asphalt cement shall be measured separately and accurately by volume. The heated aggregates, mineral filler and asphalt cement shall be mixed in the pug mill mixer for a period of not less than 45 seconds, or longer if necessary to produce a homogeneous mixture in which all particles of aggregate are coated uniformly.

(c) Drier Drum Plant.

When the bituminous mixture is prepared in a drier drum plant, the heated aggregates, mineral filler and asphalt shall be proportioned by electronic proportioning equipment and mixed until a homogeneous, uniformly coated, mix is produced. If the Engineer ascertains that proper mixing is not being obtained, adjustments shall be made in the plant operation (production rate, drier drum slope, etc.) to assure that these conditions are met. When the RAP option is used in a drier drum plant, mixing shall be continued until a homogeneous, uniformly coated mix is obtained. If a question as to the degree of coating should arise, AASHTO T 195 shall be used.

(d) All Types of Plants.

For all types of plants, the ingredients shall be heated and combined in such a manner as to produce a bituminous mixture which when discharged from the plant will in general vary not more than 10 °C (20 °F) from the temperature set by the Engineer; in all cases, the temperature shall not be more than 180 °C (350 °F) or less than 120 °C (250 °F). Wide variations in the mixture temperature of successive loads may be cause for rejection of the mix.

Whenever a hot-mix plant is being used to produce Class I, Type 1 mixtures and other types of mixtures, all hot bins shall be emptied and all hot and cold aggregate in the drier and on all collector conveyors shall be removed before the production of Class I, Type 1, mixtures may be started or resumed once the Type 1 mixture has been interrupted for the purpose of producing a different mixture.

When an anti-stripping additive is required and a liquid additive is used, it shall be added to the asphalt by means of an approved in-line blender system located between the plant supply tank and distribution on the heated aggregate. The in-line blender system shall be installed in such a location that the liquid additive cannot recirculate and contaminate the supply tank. The in-line blender system shall be capable of delivering a consistent and controllable stream of material to the asphalt under all operating weather conditions and shall be capable of controlling the introduction of additive into the asphalt within ± 10 percent of the amount specified or required. The Contractor shall use methods and procedures for handling and storage of the additive which meet manufacturer's safety recommendations.

When lime is used as the anti-stripping additive, a separate bin or tank and feeder system shall be provided to store and accurately proportion the lime onto the aggregate in either dry or slurry form. The lime and aggregate shall be mixed by a power driven pugmill prior to entering the drier. In the event lime is added in dry form, the aggregate shall be dampened sufficiently to provide a uniform coating of lime. The feeder system shall be controlled by a proportioning device which shall provide an accuracy to within ± 10 percent of the specified amount of lime solids. The proportioning device shall have a convenient and accurate means of calibration and shall be interlocked with the aggregate feed or weight system so as to maintain the required proportion. A flow indicator or sensor shall be provided and interlocked with the plant controls such that the production of the mixture will be interrupted if there is a stoppage of the lime feed. The stockpiling of lime treated aggregate will not be permitted. The methods of introducing and mixing the anti-stripping additive and aggregate shall be subject to approval by the Engineer prior to beginning production.

406.13 Mixture Criteria.

- (a) Mixture Composition. For Class I, Type 1, 2, and 3, the ingredients of the bituminous mixture shall be combined in such proportions as to produce a mixture conforming to the composition limits by weight. The job-mix formula selected shall produce a mixture falling within the following limits:

TABLE 1. MIXTURE COMPOSITION (%PASSING) 1/			
Sieve	Binder Mixture A	Binder Mixture B	Surface Mixture C, D, or E
37.5 mm (1 1/2")	100		
25 mm (1")	90 - 100		100
19 mm (3/4")		82 - 100	100
12.5 mm (1/2")	45 - 75	50 - 85	90 - 100
9.5 mm (3/8")			66 - 100
4.75 mm (#4)	24 - 42	24 - 50	24 - 65
2.36 mm (#8)	16 - 31	16 - 36	16 - 48
1.18 mm (#16)	10 - 22	10 - 25	10 - 32
300 μ m (#50)	4 - 12	4 - 12	4 - 15
150 μ m (#100)	3 - 9	3 - 9	3 - 10
75 μ m (#200)	2 - 6	2 - 6	2 - 6
Bitumen(%) 2/	3 - 9	3 - 9	3 - 9

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1/ - Based on percent of total aggregate weight.

2/ - Based on percent of total mixture weight.

One of the above gradations shall be used for leveling binder according to the requirements of Article 406.04.

For Class I, Type 1 and 2 the mixture composition shall not exceed 40 percent passing the 4.75 mm (No. 4) sieve for A & B binder courses and 40 percent passing the 2.36 mm (No. 8) sieve for C, D, & E surface courses. The 40 percent maximum limit for surface mixtures may be exceeded by 2 percent for crushed slag coarse aggregate Type 1 mixtures only.

(b) Filler/Asphalt Ratio for Class I, Type 1, 2, and 3. The ratio of material passing the 75 μ m (No. 200) sieve to asphalt cement shall not exceed 1.0 for mixture design (based on total weight of mixture).

(c) Fine Aggregate Blend Requirement For Class I, Type 1. At least 50 percent of the required fine aggregate fraction shall consist of either stone sand, slag sand or steel slag sand meeting the FA 20 gradation.

(d) Marshall Properties.

(1) For Class I, Type 1 The procedure used for Class I, Type 1 shall be 75-blow Marshall mix design.

Mixture	Voids in The Mineral Aggregate % (min.)	Voids Filled With Asphalt (%)	Air Voids (%)	Minimum Stability kN (lb)	Flow Range 0.25 mm (0.01 in.)
B Binder	13.0	65 – 75	3.5 - 4.5	8.8 (2000)	8-16
C, D, or E Surface	14.0	68 – 78	3.5 - 4.5	8.8 (2000)	8-16
C, D, or E Surface Full (Depth)	15.0	68 - 78	3.5 - 4.5	8.8 (2000)	8-16

- (2) For Class I, Type 2. The procedure used for Class I, Type 2 shall be 50-blow Marshall mix design.

Mixture	Voids in The Mineral Aggregate % (min.)	Voids Filled With Asphalt (%)	Air Voids (%)	Minimum Stability kN (lb)	Flow Range 0.25 mm (0.01 in.)
A&B Binder	13.0	65 – 75	3.5 - 4.5	7.5 (1700)	8-16
C, D, or E Surface	14.0	68 – 78	3.5 - 4.5	7.5 (1700)	8-16
C, D, or E Surface Full (Depth)	15.0	68 - 78	3.5 - 4.5	7.5 (1700)	8-16

- (3) For Class I, Type 3. The procedure used for Class I, Type 3 shall be 50-blow Marshall mix design.

Mixture	Voids in The Mineral Aggregate % (min.)	Air Voids (%)	Minimum Stability kN (lb)	Flow Range 0.25 mm (0.01 in.)
A & B Binder	12.0	2 - 4	6.6 (1500)	8-16
C Surface	13.0	2 - 4	6.6 (1500)	8-16

406.14 Transportation. Vehicles used in transporting the bituminous mixtures shall have clean and tight beds. The beds shall be sprayed with asphalt release agents which have been tested and approved for use by the Department. After spraying, the bed of the vehicle shall be in a completely raised position and it shall remain in this position until all excess asphalt release agent has been drained. When the air temperature is below 15 °C (60 °F), the bed, including the end, endgate, sides and bottom shall be insulated with fiberboard, plywood or other approved insulating material and shall have a thickness of not less than 20 mm (3/4 in.). When the insulation is placed inside the bed, the insulation shall be covered with sheet steel approved by the Engineer. Each vehicle shall be equipped with a cover of canvas or other suitable material meeting the approval of the Engineer which shall be used if any one of the following conditions are present:

- (a) Ambient air temperature is below 15 °C (60 °F).
- (b) The weather is inclement.
- (c) The temperature of the bituminous mixture immediately behind the paver screed is below 120 °C (250 °F).

The cover shall extend down over the sides and ends of the bed for a distance of approximately 300 mm (12 in.) and shall be fastened securely. The covering shall be rolled back before the load is dumped into the finishing machine. Unless artificial light

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satisfactory to the Engineer is provided, no bituminous mixture which cannot be placed and compacted during daylight shall be delivered to the work.

406.15 Placing.

- (a) General. The bituminous mixtures shall be delivered at a temperature of 120 °C - 175 °C (250 °F - 350 °F). The bituminous mixture shall be placed with a spreading and finishing machine to the typical section and grade shown on the plans or as established by the Engineer. On areas where irregularities, inaccessibility, or unavoidable objects make the use of mechanical spreading and finishing impractical, as determined by the Engineer, the mixture may be spread, raked and luted by hand.

When placing bituminous mixtures within a minimum of 60 m (200 ft) from a bridge abutment, the automatic electronic grade control on the paver shall be operated from a preset grade control stringline. At all other locations, a preset grade control stringline or a grade reference device traveling on the adjacent pavement surface shall be used. When traffic interference or sharp curves make the minimum 9 m (30 ft) device impractical, the grade reference device may be shortened to no less than 3 m (10 ft) as directed by the Engineer.

Placing the bituminous mixtures shall be away from a transverse joint. The binder course shall be kept clean until covered with the surface course. Any foreign material on the surface of the binder course shall be removed to the satisfaction of the Engineer before the surface course is placed. Intermingling of different mixes at any one paver will not be permitted.

Unless prohibited by stage construction, any bituminous concrete course lift shall be complete before construction of the subsequent lift. The longitudinal joint in all lifts shall be at the centerline of the pavement if the roadway comprises two lanes in width or at lane width if the roadway is more than two lanes in width.

When stage construction prohibits the total completion of a particular lift, the longitudinal joint in one lift shall be offset from the longitudinal joint in the preceding lift by not less than 75 mm (3 in.). The longitudinal joint in the surface course shall be at the centerline of the pavement if the roadway comprises two lanes in width or at lane width if the roadway is more than two lanes in width.

The operating speed of the paver shall not exceed that speed which is necessary to produce a uniformly spread and struck off mat having a smooth texture without tearing or segregation. The paver speed shall be mated with the required roller speed and shall not exceed that which coincides with the average rate of delivery of bituminous material to the paver to provide, as nearly as possible, continuous operation of the paver. In no case shall the speed of the paver exceed 15 m (50 ft) per minute.

A stringline shall be used as a guide for the finishing machine in order to maintain a uniform edge alignment; if any other method is proposed, it shall meet the approval of the Engineer before being used. Irregularities in the

alignment of the outside edges and along the longitudinal joint shall be corrected by adding or removing bituminous mixtures before the edges are rolled. Excess bituminous mixtures deposited on the existing base, binder course or surface course outside the limits of the lane being laid shall be removed immediately and disposed of as directed by the Engineer.

A straightedge at least 1 m (4 ft) in length and equipped with a carpenter's level shall be available at the spreading and finishing machine to check the surface of the bituminous mixture for transverse slope and longitudinal surface variations.

- (b) Test strip, for Class I, Type 1 and 2. At the start of both binder and surface course placement, and at other times as required by the Engineer, the Contractor shall construct a test strip for the purpose of evaluating the properties of the bituminous mixture. The test strip shall consist of no more than 180 metric tons (200 tons) of bituminous mixture placed at a paver speed of no more than 8 m (25 ft) per minute.

Within the test strip, two or more growth curves will be constructed using a vibratory roller. The mixing and placement shall stop until the test strip has been evaluated. If the test strip results are satisfactory, the mixing and placement may be resumed and a rolling pattern established. If the test strip results are unsatisfactory, the Engineer will make appropriate adjustments and another test strip shall be constructed. This procedure will be followed until a satisfactory test strip is obtained. The test strip requirement may be waived by the Engineer.

- (c) Rolling Pattern for Class I, Type 1 and 2. Once the test strip(s) requirements have been satisfied, an appropriate rolling pattern shall be established for both binder and surface courses. The purpose of the rolling pattern is to determine the types of rollers, number of passes, roller speed, paver speed, and sequence of operations necessary to meet the density requirements specified herein. Once a satisfactory rolling pattern is established, it shall be continued for the balance of the work unless otherwise changed by the Engineer.

406.16 Compaction.

- (a) Rolling. Immediately after each lift of level binder, binder, or surface course mixture is placed, each lift shall be compacted with equipment meeting the requirements listed in the following Table 1.

TABLE 1. MINIMUM ROLLER REQUIREMENTS FOR BITUMINOUS CONCRETE, CLASS I

	BREAKDOWN (One of the Following)	INTERMEDIATE	FINAL (One or more of The following)	MINIMUM ADDITIONAL ROLLER REQUIREMENTS	DENSITY REQUIREMENT
Level Binder < 40 mm (1 1/2 in.)	P		T _F , V _S , 3W,P,T _B		To satisfaction of Engineer
Class I, Type 1 and 2 Level Binder (other than above) Binder 1/ Surface 1/	3W,P,T _B , V _D	P	T _B , T _F , V _S	If the required density is not Obtained, one of the following Additional rollers 3W,P, T _B , V _D	As specified 406.16(b)
Bridge Decks 2/	T _B		T _F		As specified
Class I, Type 3 Level Binder (other than above) Binder 1/ Surface 1/	3W,P,T _B , V _D	P	T _B , T _F , V _S		To satisfaction of the Engineer

- 1/ If the average delivery at the job site is 75 metric ton/hr (85 ton/hr) or less, any roller combination may be used provided it includes a steel wheeled roller and the required density and smoothness is obtained.
- 2/ One T_B may be used for both Breakdown and Final rolling on bridge decks 90 m (300 ft) or less in length, except when the air temperature is less than 15 °C (60 °F).

EQUIPMENT DEFINITION

- | | |
|----------------|--|
| V _S | - Vibratory roller, static mode, minimum 2.2 kg/mm (125 lb/in.) of roller width. Max. speed = 5 km/h (3 mph) = 80 m/min (264 ft/min).
If the vibratory roller does not eliminate roller marks, its use shall be discontinued and a tandem roller adequately ballasted to remove roller marks shall be used. |
| V _D | - Vibratory roller, dynamic mode, operated at a speed to produce not less than 30 impacts/m (10 impacts/ft). |
| P | - Pneumatic-tired roller, max. speed 5.5 km/h (3 1/2 mph) = 92 m/min (308 ft/min) Minimum tire pressure 550 kPa (80 psi).
Pneumatic-tired roller shall be equipped with heat retention shields. The self-propelled pneumatic-tired roller shall develop a compression of not less than 53 N (300 lb) nor more than 88 N/mm (500 lb/in.) per mm (per in.) of width of the tire tread in contact with the bituminous surface. |
| T _B | - Tandem roller for breakdown rolling, 7 to 11 metric tons (8 to 12 tons), 44 to 70 N/mm (250 to 400 lb/in.) of roller width, max. speed 5.5 km/h = 92 m/min (3 1/2 mph = 308 ft/min) |
| T _F | - Tandem roller for final rolling, 35 to 70 N/mm (200 to 400 lb/in.) of roller width with minimum roller width of 1.25 m (50 in.). Ballast shall be increased if roller marks are not eliminated. Ballast shall be decreased if mat shoves or distorts. |
| 3W | - Three wheel roller, max. speed 5 km/h = 80m/min (3 mph = 264 ft/min), 53 N to 70 N/mm (300 to 400 lb/in.) of roller width. The three-wheel roller shall weigh 9 to 11 metric tons (10 to 12 tons). |

Art. 406.16 Bituminous Concrete Binder And Surface Course Class I

When initial rolling causes undue displacement, haircracking or checking in either the binder course or the surface course, the time of rolling shall be adjusted by the Engineer to correct these conditions.

Rolling of the first lane of binder and surface course shall start longitudinally at the edge having the lower elevation and progress to the other edge, overlapping on successive trips to obtain uniform coverage. The roller shall not pass over an unprotected edge of the freshly laid bituminous mixture, unless directed by the Engineer. When directed by the Engineer, the edge shall be rolled with a pneumatic tired roller. When laying the bituminous mixture adjacent to a previously placed lane, the first pass of the roller shall be along the longitudinal joint on the fresh mixture with the compression wheel not more than 150 mm (6 in.) from the joint. The second pass of the roller shall overlap the longitudinal joint not more than 300 mm (12 in.) on the previously placed lane after which the rolling shall proceed from the low side of the transverse slope to the high side, overlapping uniformly. Each stop shall be regulated to prevent trapping of water on the rolled surface. The steel-wheeled rollers shall be operated with the compression wheels toward the direction of paving.

The speed of the roller at all times shall be slow enough to avoid displacement of the bituminous mixture. If displacement occurs, it shall be corrected at once by raking and applying a fresh bituminous mixture where required. To prevent adhesion of the bituminous mixture to the roller, the wheels shall be kept properly moistened without an excess of water.

Rolling of the binder and surface courses shall be continued until all roller marks are eliminated and the bituminous mixture is satisfactorily compacted.

When required by the Engineer, the surface course shall be rolled diagonally in two directions with a tandem roller, the second rolling crossing the lines of the first, and, if the width of the pavement permits, it shall also be rolled at right angles to the centerline.

In all places inaccessible to the rollers, such as locations adjacent to curbs, gutter, headers, manholes and similar structures, the required compaction shall be secured with tampers.

Any bituminous mixture that becomes loose, broken, mixed with foreign material or is in any way defective shall be removed and replaced with fresh hot mixture and compacted to conform to the surrounding area.

- (b) Density. The density of the finished binder or surface course shall be measured either by nuclear test methods or from cores obtained by the Contractor at random locations identified by the Engineer.

- (1) Compaction.

- a. Class I, Type 1. Bituminous concrete binder, leveling binder [40 mm (1 1/2 in.) or greater], or surface course shall be compacted to an average density of 92.0 to 96.0 percent of the theoretical maximum density as determined by Illinois Modified AASHTO T

209. No individual test shall be below 91.0 percent. The average shall be based on tests representing one day's production. A minimum of two tests shall be conducted for a day's production.

- b. Class I, Type 2. Bituminous concrete binder, leveling binder [40 mm (1 1/2 in.) or greater], or surface course shall be compacted to an average density of 93 to 97 percent of the maximum theoretical density as determined by Illinois Modified AASHTO T 209. No individual test shall be below 91 percent. The average shall be based on tests representing a day's production. A minimum of two tests shall be conducted for a day's production.

- (2) Coring. Coring shall be conducted using procedures and equipment that shall provide undamaged, undistorted cores of a diameter of no less than 90 mm (3 5/8 in.).

The holes caused by the removal of the cores shall be refilled immediately with a bituminous material meeting these specifications, compacted and finished to the satisfaction of the Engineer.

The Contractor shall promptly transport obtained cores to the plant laboratory for density determination.

Determination of bulk specific gravity of cores will be performed by the Engineer using procedures specified in IL 166-86 or, if applicable, IL 275-86.

No less than four nor more than 20 cores per day will be required by the Engineer for the purpose of acceptance and/or comparison with nuclear gage density measurements.

The cost of this work will not be paid for separately, but shall be considered as included in the unit price bid for the bituminous concrete item involved.

- (3) Nuclear Methods. When density is measured by nuclear methods, a test shall consist of the average of five, one-minute determinations located across the width of a 3.6 to 4.3 m (12 to 14 ft) paving lane.

Density tests, either core or nuclear, shall be performed at randomly selected locations in maximum 800 m (1/2 mile) intervals for lifts 75 mm (3 in.) or less in thickness. For lifts thicker than 75 mm (3 in.), a test shall be performed in maximum 400 m (1/4 mile) intervals. Nuclear testing of lifts 100 mm (4 in.) or thicker shall be performed in the direct transmission mode.

If density is not within the specified limits, mixture production and laydown shall be evaluated and corrective action taken prior to continuing the next day. Additional compactive effort may be required through modifying the rolling pattern or adding rollers. All changes to the laydown and production operation shall be at the Contractor's expense and approved by the Engineer. Density within the limits shall be achieved without excess aggregate breakage, the formation of hairline cracks, separation of the lift from the underlying layer, or other damage.

406.17 Joints. Joints between old and new pavements or between successive days' work shall be made so as to ensure thorough and continuous bond between the old and new mixtures.

Transverse construction joints in previously laid material may be constructed by cutting the material back for its full depth so as to expose a fresh surface. Where a wooden header is used at a construction joint, the cutting may be omitted provided the joint conforms to the specified thickness.

406.18 Butt Joints. When butt joints are to be constructed under traffic, the Contractor shall provide and maintain temporary bituminous ramps at both upstream and downstream ends of the area removed. The Contractor shall have sufficient bituminous material meeting the approval of the Engineer at the worksite to construct the ramps before beginning the pavement surface removal. Surface removal will be according to Section 440. Cold-milled bituminous tailings will not be acceptable for ramps. The temporary ramps shall be constructed immediately upon completion of the removal operation and the area between shall be leveled and filled as necessary. Ramps shall have a minimum taper rate of 1:40 (V:H). The temporary ramps shall be removed prior to placing the proposed surface course.

The Contractor shall not begin construction of butt joints prior to beginning general operations on the project. If work is suspended for the winter season prior to completion of surface course construction, precut butt joints shall be filled to the elevation of the existing pavement surface with compacted bituminous concrete surface course or binder course.

406.19 Approaches, Intersections and Entrances. The thickness of the bituminous surface at the ends of the proposed resurfacing and adjacent to railroad grade crossings shall be diminished uniformly to a featheredge at a rate of 1:240 (V:H). At paved intersections, the bituminous resurfacing shall be feathered out in a distance of 3 m (10 ft), unless otherwise directed by the Engineer. At these locations, the thickness of the surface course shown on the plans shall be maintained to a point where the binder course has been reduced to 25 mm (1 in.) in thickness. Beyond this point, surface course only shall be used. At these locations where the bituminous surface is diminished uniformly to a featheredge, the last 1.5 m (5 ft) shall receive an additional application of prime as specified in Article 406.02, just prior to placing the bituminous mixture. This prime will not be paid for separately but shall be included in the contract unit bid price for Bituminous Concrete Surface Course.

Unpaved intersections and entrances shall be constructed as shown on the plans or designated by the Engineer. The existing surface shall be bladed, shaped and compacted before the prime is placed. The prime coat at unpaved intersections shall be as specified in Article 406.02, and applied at the rate of 1 to 2 L/sq m (0.25 to 0.50 gal/sq yd), unless otherwise directed by the Engineer. The cost of this work will not be paid for separately but shall be included in the contract unit bid price for Bituminous Concrete Surface Course.

The shoulder aggregate shall be omitted at intersections, when directed by the Engineer, and resurfacing material shall be placed as specified for entrances.

406.20 Multi-Lane Pavement Resurfacing. For multi-lane pavement resurfacing, the layer(s) of binder course shall be placed and compacted prior to start of placement of the surface course mixture. When bituminous shoulder resurfacing is not being constructed simultaneously with the mainline pavement, a bituminous concrete wedge at least 1 m (3 ft) wide shall be placed on the shoulder simultaneously with binder placement on the mainline pavement. The wedge shall be constructed according to the details shown on the plans or as directed by the Engineer. The cost of this wedge shall be included in the cost of bituminous shoulders as specified in Section 482.

406.21 Surface Tests. The completed surface course will be tested for smoothness in the wheel paths with a 5 m (16 ft) straightedge. Surface variations of the mainline pavement shall not exceed 5 mm (3/16 in.). Mainline pavement is defined as all pavement other than ramps which will be posted for speeds of 70 km/h (40 mph) or less, acceleration and deceleration lanes, crossovers, side street returns, and other miscellaneous pavement surfaces as determined by the Engineer. In all areas other than mainline pavement, surface variations shall not exceed 10 mm (3/8 in.).

The smoothness test will not be performed on binder courses, but the Engineer reserves the right to require corrective measures when obvious surface variations are evident.

For each variation in the surface course that exceeds the maximum permissible specified above but is less than 20 mm (3/4 in.), a deduction will be made in the tonnage of surface course mixture measured for payment as specified in the following table:

Binder and/or Surface Course Plan Thickness, mm (in.)	Surface Course Mixture Deduction Per Variation, metric ton (ton)
(Existing Surface Not Reprofiled)	
70 (2 3/4) or more	2 (2)
Less than 70 (2 3/4)	1 (1)
(Existing Surface Reprofiled)	
All	2 (2)

In all cases where the variation in surface course equals or exceeds 20 mm (3/4 in.), the entire area affected shall be removed and replaced with fresh surface course mixture at the entire expense of the Contractor.

The Contractor shall furnish a 5 m (16 ft) straightedge and shall provide for its jobsite transportation. The cost of furnishing the straightedge and providing for its jobsite transportation shall be considered as included in the unit price bid for the various items of bituminous concrete surface course involved, and no additional compensation will be allowed.

406.22 Protection of Pavement. The Contractor shall protect all sections of newly compacted binder and surface courses from traffic until they have hardened to the satisfaction of the Engineer.

406.23 Method of Measurement.

- (a) Contract Quantities. The requirement for the use of contract quantities shall be according to 202.07(a).
- (b) Measured Quantities. Bituminous priming material will be measured for payment as specified in Section 1009. Water added to emulsified asphalt as specified in Article 406.02 will be included in the quantities measured for payment.

Aggregate for covering prime coat will be measured for payment in metric tons (tons). The aggregate will be weighed on platform scales meeting the approval of the Engineer.

Mixture for cracks, joints and flangeways, leveling binder (machine method), leveling binder (hand method), binder course, and surface course mixtures will be measured for payment in metric tons (tons) on approved platform scales, surge bin scales or surge bin hopper scales equipped with automatic printers as specified in Article 1102.01(a)(13). Bituminous mixtures produced by a batch-type mixing plant may be measured by batch weights only when surge or storage bins are not used. An occasional check to verify the accuracy of the batch weights or automatic printers, will be made by weighing full truck loads of the bituminous mixtures on an approved platform scale at the plant or on a commercial scale approved by the Engineer. If it becomes apparent that the batch weights or automatic printers are not accurate in measuring the bituminous mixture, the scales and/or printers shall be repaired immediately. Quantities of materials wasted or disposed of in a manner not called for in the contract will be deducted from the final total measured quantities. The Contractor shall furnish a load ticket (duplicate tickets if required) upon which is recorded the net weight of the bituminous mixture in each truck, as specified in Article 1102.01(a)(13). In addition, the load ticket shall have sufficient space for signatures, identification of the bituminous mixture, date of delivery, and any other data which the Engineer may require. The Contractor shall submit the load ticket to the Engineer at the work site when the truck arrives.

Measurement for payment will not be made for any bituminous concrete mixture in excess of 103 percent of the quantity specified by the Engineer.

Surface removal for butt joints will be measured for payment in place and the area computed in square meters (square yards).

Temporary ramps will be measured for payment in place and area computed in square meters (square yards).

When the option of Class I, Type 1 and 2 mixture on shoulders is used, and shoulders at 1.8 m (6 ft) or less in width are placed simultaneously with the traffic lane as specified in Section 482, the quantity of bituminous mixture placed on the traffic lane will be limited to a calculated tonnage based upon actual mat width and length, plan thickness or a revised thickness authorized by the Engineer, and design mix weight per millimeter (in.) of thickness. The difference between the total actual tonnage placed and the calculated tonnage used on the traffic lane will be measured and paid for as Bituminous Shoulders according to Section 482.

When a bituminous concrete wedge is placed simultaneously with the binder course as specified in Article 406.20, the quantity of binder course placed on the traffic lane will be limited to 103 percent of the quantity specified by the Engineer. The difference between the total actual tonnage placed and 103 percent of the tonnage specified by the Engineer will be measured and paid for as Bituminous Shoulders according to Section 482.

406.24 Basis of Payment. Prime Coat will be paid for at the contract unit price per liter (gallon) or per metric ton (ton) for BITUMINOUS MATERIALS (PRIME COAT), and per metric ton (ton) for AGGREGATE (PRIME COAT).

The bituminous concrete surfacing will be paid for at the contract unit price per metric ton (ton) for MIXTURE FOR CRACKS, JOINTS AND FLANGEWAYS; at the contract unit price per metric ton (ton) for LEVELING BINDER (MACHINE METHOD), LEVELING BINDER (HAND METHOD) and BITUMINOUS CONCRETE BINDER COURSE, of the type specified; at the contract unit price per metric ton (ton) for LEVELING BINDER (MACHINE METHOD) and BITUMINOUS CONCRETE BINDER COURSE, of the mixture and type specified; and at the contract unit price per metric ton (ton) for BITUMINOUS CONCRETE SURFACE COURSE, CLASS I, of the mixture and type specified.

Surface removal for butt joints will be paid for at the contract unit price per square meter (square yard) for BITUMINOUS SURFACE REMOVAL - BUTT JOINT and PORTLAND CEMENT CONCRETE SURFACE REMOVAL - BUTT JOINT.

Temporary ramps will be paid for at the contract unit price per square meter (square yard) for TEMPORARY RAMP.

Test strips constructed for the purpose of evaluating the properties of a bituminous mixture will be paid for at the contract unit price each for CONSTRUCTING TEST STRIP. A test strip will be considered as having been constructed when a satisfactory test strip has been obtained for a specific bituminous mixture. If the Contractor requests and is granted approval for a mix design change, he/she shall construct a test strip for the new mix design at his/her own expense, and no additional compensation will be allowed.

If an anti-stripping additive is required for any bituminous mixture, the cost of the additive will be paid for according to Article 109.04. The cost incurred in introducing the additive into the mixture will not be paid for separately, but shall be considered as included in the contract unit price bid for the bituminous concrete item involved. No additional compensation will be awarded to the Contractor because of reduced production rates associated with the addition of the additive.

If provided as a payment item, the preparation of base will be measured and paid for as specified in Section 358. If not provided as a payment item, the cost of the preparation of the base will be paid for according to Article 109.04.

SECTION 407. BITUMINOUS CONCRETE PAVEMENT (FULL-DEPTH)

407.01 Description. This work shall consist of constructing a full-depth bituminous concrete pavement structure comprised of one or more bituminous

concrete binder courses and a bituminous concrete surface course on a prepared subgrade.

407.02 Materials. Materials shall meet the requirements of Article 406.02 except that if a light fog prime is required by the Engineer, between bituminous concrete lifts, the bituminous material for prime shall be RC-70.

407.03 Equipment. Equipment shall meet the requirements of Article 406.03 and Article 1101.10.

CONSTRUCTION REQUIREMENTS

407.04 General. Except as specified, Bituminous Concrete Pavement (Full-Depth) shall be constructed according to the applicable portions of Section 406, with binder and surface course types corresponding to the full-depth pavement type shown on the plans.

407.05 Subgrade. The subgrade shall be prepared according to Section 301 except Articles 301.04 and 301.05 will not apply.

407.06 Placing. Placing of bituminous mixtures shall be according to Article 406.15 and the following:

The compacted thickness of the initial lift of binder course shall be a minimum 100 mm (4 in.). Succeeding lifts shall be not more than 100 mm (4 in.) thick when compacted except that the top lift of binder shall have a minimum 50 mm (2 in.) thick compacted layer. If a vibrating roller is used for breakdown, the compacted lift thickness of lower layers of binder may be increased to 150 mm (6 in.), provided the required density is obtained.

Unless prohibited by stage construction or other restricted access, any bituminous concrete course lift shall be complete before construction of the subsequent lift. The longitudinal joint in all lifts shall be at the centerline of the pavement if the roadway comprises two lanes in width or at lane width if the roadway is more than two lanes in width.

When stage construction prohibits the total completion of a particular lift, the longitudinal joint in one lift shall be offset from the longitudinal joint in the preceding lift by not less than 75 mm (3 in.). The longitudinal joint in the surface course shall be at the centerline of the pavement if the roadway comprises two lanes in width or at lane width if the roadway is more than two lanes in width.

Prior to placing the initial lift of the bituminous concrete binder course, all trimmings and other loose material shall be removed from the prepared subgrade to prevent blowing and dusting of bituminous concrete layers.

Each compacted lift of bituminous concrete mixture shall be thoroughly clean of all dirt, dust, and foreign material to the satisfaction of the Engineer before the next lift is placed. All cleaning operations such as blowing, power brooming, washing, blading or milling necessary to thoroughly clean the bituminous surfaces shall be at the Contractor's expense.

When directed by the Engineer, a light fog tack coat of RC-70 shall be applied between lifts of bituminous concrete material at a rate of approximately 0.1 L/sq m (0.02 gal/sq yd).

407.07 Pipe Underdrains. If pipe underdrains are to be constructed along the edges of the full-depth pavement, construction of the pipe underdrains shall not be started until at least 240 mm (9.5 in.) of bituminous concrete binder course or the entire thickness of the full-depth pavement, whichever is the lesser, is in place. Material excavated from the trench for the underdrain shall not be deposited or windrowed on any portion of the full-depth pavement.

407.08 Hauling on the Partially Completed Full-Depth Pavement. Trucks will be permitted on partially completed segments of full-depth bituminous concrete pavement only to deliver bituminous mixture to the paver except that hauling on partially completed segments will be permitted if the thickness of binder in-place is greater than 100 mm (4 in.), the last paving lift has cooled a minimum of 24 hours and the air temperature is below 30 °C (85 °F). When hauling is allowed, the load limit restrictions given in the following table will be strictly enforced. In addition, a traffic pattern shall be established that will vary across the width of the pavement and "tracking" of vehicles one directly behind the other will not be allowed at any time.

LOAD LIMIT RESTRICTIONS		
Total Lift Thickness mm	Type of Hauling Traffic	
	Below 30 °C (85 °F)	30 °C (85 °F) & above
100-180 (4-7)	Unloaded	None
180-240 (7-9.5)	Legally Loaded	Unloaded
Greater than 240 (9.5)*	Legally Loaded	Legally Loaded

*With the last lift having cooled a minimum of 12 hours.

Permissive hauling on the partially completed pavement, however, does not relieve the Contractor of his/her responsibility for damage done to the pavement. Any portion of the full-depth pavement that is damaged by hauling on it shall be removed and replaced, or otherwise repaired to the satisfaction of the Engineer, by the Contractor at his/her own expense.

Cross-overs used to transfer haul trucks from one roadway to the other shall be not less than 300 m (1000 ft) apart and shall be constructed of material that will prevent tracking dust or mud on the completed bituminous concrete layers. The cost of constructing, surfacing, maintaining and removing cross-overs shall be at the Contractor's expense.

407.09 Surface Tests. The finished surface of the pavement shall be tested using a California Profilograph or an approved equivalent or a 5 m (16 ft) straightedge as specified below. The Contractor shall remove all objects and debris from the pavement surface prior to the required profilograph or straightedge measurements.

- (a) 5 m (16 ft) Straightedge. Pavement surfaces listed in Table 1 shall be tested in the wheel paths with a 5 m (16 ft) straightedge set to the tolerance specified.

Table 1	
Location	Tolerance
Ramps, Loops and Climbing Lanes	6 mm (1/4 in.)
Mainline Gaps \leq 160 m (0.1 mile)	6 mm (1/4 in.)
Bridge Approaches	6 mm (1/4 in.)
Side Roads & Side Streets > 180 m (600 ft) in length	6 mm (1/4 in.)
15 m (50 ft) from Bridge Approaches or Existing Pavement or Mainline Gaps	6 mm (1/4 in.)
All curves \leq 300 m (1000 ft) radius including S.E. transitions	10 mm (3/8 in.)
Acceleration Deceleration Lanes	10 mm (3/8 in.)
Side Streets \leq 180 m (600 ft) in length	10 mm (3/8 in.)
Turn Lanes, Storage Lanes and Crossovers, Etc.	10 mm (3/8 in.)
Intersections	10 mm (3/8 in.)

A 5 m (16 ft) straightedge set to a 5 mm (3/16 in.) tolerance will be used to test the mainline pavement in lieu of the California Profilograph where the posted speed, as determined by the contract signing requirements, is:

- (1) Less than or equal to 70 km/h (40 mph) or
- (2) Greater than 70 km/h (40 mph) with a net project length of less than 1600 m (1 mile).

Surface variations which exceed the above tolerances shall be marked by the Engineer and removed by the Contractor with an approved grinding device consisting of multiple saws. The use of the bush hammer or other impact devices will not be permitted.

- (b) Profilograph.

- (1) General. All mainline pavement shall be tested with a California Profilograph or approved equivalent. Mainline pavement is defined as all pavement except that listed in Table 1 located in (a) above and other miscellaneous pavement surfaces as determined by the Engineer. The profile will terminate 15 m (50 ft) from each wide flange beam terminal joint, bridge approach pavement or existing pavement which is joined by the new pavement.

The Contractor shall furnish paving equipment and employ methods that produce a riding surface having a maximum profile index of 160

mm/km (10 in./mile) for any 160 m (0.1 mile) segment except as provided for elsewhere. When starting up paving operations or after a long shutdown period, pavement surface will be tested the first several days with the profilograph as soon as the surface has cooled sufficiently to allow testing. For the purpose of surface tests, paving operations for Bituminous Concrete Pavement (Full-Depth) shall be interpreted as being concerned with the placement and compaction of the bituminous concrete surface course. Once the initial pavement smoothness, paving methods, and paving equipment are acceptable to the Engineer, daily profiles will be run during the next working day following placement of the pavement surface course. The Contractor may use his/her profilograph on other jobs simultaneously provided such use will not interfere with the necessary testing as outlined above and scheduling can be agreed to by the respective Resident Engineers involved. If the contract does not require the Contractor to furnish a profilograph, the Department will furnish it.

- (2) Profile Index and Price Adjustments. A daily Profile Index will be determined for each day's paving. Determination of the Profile Index will be according to Test Method No. California 526-D. A day's paving is defined as a minimum of 300 m (1000 ft) of paving placed in a single day. If less than 300 m (1000 ft) is paved, the day's production shall be grouped with the subsequent day's production. If a profile Index of 235 mm/km (15 in./mile) is exceeded in any day's production, the initial testing procedures will be resumed until the index is less than 235 mm/km (15 in./mile).

On the first paving day, a profile up to 235 mm/km (15 in./mile) for any 160 m (0.1 mile) segment will be accepted without applicable Price Adjustment and the profile will be excluded from the average profile index determined for the project.

Pavement Profiles will be taken 1 m (3 ft) from and parallel to each edge for pavement placed at a 3.6 m (12 ft) width, or less. When pavement is placed at a greater width than 3.6 m (12 ft), the profile will be taken 1 m (3 ft) from and parallel to each edge and each side of the planned longitudinal joint. When the pavement being constructed is contiguous with an existing parallel pavement which was not constructed as a part of this contract, the profile parallel with the edge of pavement contiguous with the existing pavement will not be taken. The profile index for each 160 m (0.1 mile) section will be the average of the profiles taken.

Acceptance and pay adjustments for Bituminous Concrete Pavement (Full Depth) will be based upon the smoothness of the final surface. Measurements on prior lifts are encouraged.

All areas represented by high points having deviations in excess of 8 mm (0.3 in.) in 8 m (25 ft) shall be corrected by the Contractor with an approved grinding device consisting of multiple saws. The use of a bushhammer or other impact devices will not be permitted.

When the average profile index for the entire project length does not exceed 8 mm/km (0.5 in./mile), and no 160 m (0.1 mile) section has a profile index exceeding 160 mm/km (10 in./mile), the contract unit price shall be increased according to the following Price Adjustment Schedule. When the profile index for the 160 m (0.1 mile) section does not exceed 160 mm/km (10 in./mile) payment will be made at the contract unit price for that section. When the profile index for a 160 m (0.1 mile) section exceeds 160 mm/km (10 in./mile) but does not exceed 235 mm/km (15 in./mile) the contract unit price for that section will be reduced according to the following Price Adjustment Schedule.

PRICE ADJUSTMENT SCHEDULE

<u>Profile Index for Entire Project mm/km (in./mile)</u>	<u>Percent of Unit Bid Price</u>
3 (0.20) or less	103
Over 3 (0.20) to 6 (0.25)	102
Over 6 (0.25) to 8 (0.50)	101
 <u>Profile Index for 160 m (0.1 mile) Section, mm/km (in./mile)</u>	 <u>Percent of Unit Bid Price</u>
Over 8 (0.50) to 160 (10)	100
Over 160 (10) to 175 (11)	98
Over 175 (11) to 190 (12)	96
Over 190 (12) to 205 (13)	94
Over 205 (13) to 220 (14)	92
Over 220 (14) to 235 (15)	90
Over 235 (15)	Corrective work required

- (3) Correction: Except for bump corrections, the Contractor will not be allowed to make corrective grinding to increase his/her percent of pay when the final profile index is 235 mm/km (15 in./mile) or less.

At the Contractor's option and expense, each 160 m (0.1 mile) section of pavement with a profile index greater than 235 mm/km (15 in./mile) shall be either corrected until the measured profile index is less than or equal to 235 mm/km (15 in./mile) or removed and replaced.

When the Contractor chooses the corrective grinding, 90 percent of the contract unit price will be the maximum amount of pay the Contractor shall receive for the section of pavement. When the Contractor chooses to remove and replace the section, the Contractor will be paid the percent of contract unit price which corresponds to the replaced section's final profile index.

On those 160 m (0.1 mile) pavement sections where corrections are necessary, second profilograph runs will be performed to verify that corrections have produced a Profile Index of 235 mm/km (15 in./mile) or less. If the initial Profile Index is less than 235 mm/km (15 in./mile), only

the areas representing 8 mm (0.3 in.) deviations in 8 m (25 ft) will be reprofiled for correction verification.

All ground areas shall be neat, rectangular areas of uniform surface appearance, bounded laterally by lane lines or edges of pavement. Determination of pavement thickness will be made after the removal of high spots.

407.10 Tolerance in Thickness. Determination of pavement thickness shall not be performed until after pavement surface tests and all corrective grinding have been completed as described above in Article 407.09. Adjustments made in the contract unit price for pavement deficient in thickness will be in addition to those made for Profile Index as specified in Article 407.09.

Determination of pavement thickness will be based on cores taken from a unit of the pavement having a surface area equal to or greater than 420 sq m (500 sq yd). Determination of pavement thickness for areas less than 420 sq m (500 sq yd) may be made from edge of pavement measurements or from before and after cross section measurements, as determined by the Engineer. Computation of thickness, and requirements relative to deficient thickness, shall be as specified herein:

- (a) Length of Units. The unit of surface area will be a continuous strip of pavement 300 m (1000 ft) in length when possible. When the length of a continuous strip of pavement is less than 300 m (1000 ft), the length of the unit to be used shall be identical to the length of the continuous strip.
- (b) Width of Units. The width of a unit will be the width from the pavement edge to the adjacent lane line, from one lane line to the next, or between pavement edges for single-lane pavements.
- (c) Cores. Cores will be taken from the pavement at such points as the Engineer shall select. When computing the thickness of a unit, not less than three cores will be taken.
- (d) Unit Deficient in Thickness. In considering any portion of the pavement that is deficient, the limits of the unit to be used in computing the deficiency will be determined by the Engineer, except that no portion of the pavement once included in such computation will be included in a second computation.
- (e) Determination of Thickness. The thickness of the pavement at the cored points will be the average caliper measurement of the cores taken at the respective points. The average thickness of the pavement will be determined by obtaining a weighted average of the thickness at the points where cores are taken from the particular unit, considering that each core represents the thickness of the pavement extending longitudinally in both directions half way to the nearest core, or to the end of the unit. Measurements which exceed the specified plan thickness will be considered as the specified thickness. Measurements which are less than the specified plan thickness by more than five percent, determined as specified in paragraphs (h) and (i) below, will not be included in obtaining a weighted average thickness.

- (f) **Thickness Equals or Exceeds Specified Thickness.** When the average thickness of a unit, determined as specified above, equals or exceeds the specified plan thickness, payment will be made at the contract unit price per square meter (square yard) for the specified thickness.
- (g) **Thickness Deficient by Five Percent or Less.** When the average thickness of a unit determined as specified above, is less than the specified plan thickness by five percent or less, an adjusted unit price will be used in computing payment for the pavement involved. The adjusted unit price will be a percentage of the contract unit price as given in the following schedule:

<u>Average Thickness Deficiency in Percent of Plan Thickness</u>	<u>Percent of Contract Unit Price</u>
0.0 to 2.0	100
2.1 to 3.0	80
3.1 to 4.0	72
4.1 to 5.0	68

- (h) **Thickness Deficient by More than Five Percent But Not More Than Ten Percent.** When the thickness of the pavement at a cored point is less than the specified thickness by more than five percent but not more than ten percent, additional cores will be taken on each side of such thin core at such intervals as the Engineer may select until cores are obtained which are not deficient in thickness by more than five percent. The average thickness of the pavement between the last points cored, and for the full width of the pavement unit, excepting any areas which are deficient in thickness by more than ten percent, will be determined as a weighted average of the thickness at the cored point and an adjusted unit price will be used in computing payment for the pavement involved. The adjusted unit price will be a percentage of the contract unit price as given in the following schedule:

<u>Average Thickness Deficiency in Percent of Plan Thickness</u>	<u>Percent of Contract Unit Price</u>
5.1 to 7.5	57
7.6 to 10.0	50

- (i) **Thickness Deficient by More Than Ten Percent.** When the thickness of pavement at a cored point is less than the specified thickness by more than ten percent, additional cores will be taken on each side of such thin cores at such intervals as the Engineer may select until cores are obtained which are deficient in thickness by ten percent or less. All pavement between the last points cored and for the full width of the unit of pavement will be considered thin by more than ten percent, and such thin pavement shall be removed and replaced with pavement of the specified thickness unless the Engineer, at his/her option, permits in writing such thin pavement to remain in place.

If the thin pavement is removed and replaced with pavement of the specified thickness, the replacement pavement will be paid for at the contract unit price per square meter (square yard), and no payment will be made for the thin pavement removed nor for the cost of removal. If the thin pavement is

left in place, the Contractor will receive no compensation for the thin pavement and, in addition, an amount equal to two times the contract cost of the thin pavement will be deducted from the compensation due the Contractor.

407.11 Widening. The 5 m (16 ft) straightedge shall be used in lieu of the profilograph on projects where the pay item Bituminous Binder Course in square meters (square yards) is specified.

407.12 Method of Measurement.

- (a) Contract Quantities. The requirements for the use of contract quantities shall conform to Article 202.07(a).
- (b) Measured Quantities. Bituminous Concrete Pavement (Full-Depth) and Bituminous Binder Course will be measured in place and the quantity for payment shall be computed in square meters (square yards). The width of measurement shall be the top width of the bituminous concrete course as shown on the plans.

407.13 Basis of Payment. Bituminous Concrete Pavement (Full-Depth) will be paid for at the contract unit price per square meter (square yard) for BITUMINOUS CONCRETE PAVEMENT (FULL-DEPTH) of the type and thickness specified.

When a light fog tack coat is required, it will be paid for according to Article 109.04.

When widening is being constructed and the entire pavement is being resurfaced, the binder for the widening will be paid for at the contract unit price per square meter (square yard) for BITUMINOUS CONCRETE BINDER COURSE, of the type and thickness specified. The surface and binder course resurfaced over the entire pavement will be measured and paid for according to Articles 406.23 and 406.24.

If the contract requires the Contractor to furnish a profilograph, furnishing a California type profilograph or approved equivalent, providing for its maintenance and jobsite transportation, furnishing the profile scale and bump template, profilograph paper and recorder pens, as outlined above, will be paid for at the lump sum price for FURNISH PROFILOGRAPH.

The cost of furnishing a 5 m (16 ft) straightedge and providing for its jobsite transportation shall be considered as included in the various items involved and no additional compensation will be allowed.

SECTION 408. INCIDENTAL BITUMINOUS SURFACING

408.01 Description. This work shall consist of the preparation of the base, the application of bituminous priming material, and the construction of a bituminous surface.

408.02 Bituminous Mixtures. The bituminous mixture for the incidental bituminous surface shall meet the requirements of the following Sections:

Item	Article/Section
(a) Surface Course Mixture for Bituminous Concrete (Class I)(Note 1)	406

Note 1. Type 2, Mixture C or D shall be used.

CONSTRUCTION REQUIREMENTS

408.03 General. The base shall be prepared according to Section 358.

Areas where incidental bituminous surfacing will be subject to vehicular traffic shall have the base primed with Asphalt: RC-70, Asphalt: MC-30, or the same as used for prime on the mainline paving. The prime shall be applied according to Article 406.06 or 406.07 by methods approved by the Engineer. The bituminous prime material which will be subject to traffic shall be covered immediately following its application with fine aggregate spread at a uniform rate of 1 to 2 kg/sq m (2 to 4 lb per sq yd) by hand methods. The fine aggregate for the prime coat shall conform to Article 1003.03. The exact rate of application of prime and fine aggregate will be specified by the Engineer.

The bituminous mixture may be spread and finished by approved hand methods or a finishing machine approved by the Engineer.

The bituminous mixture which will be subjected to vehicular traffic shall be rolled and compacted to the satisfaction of the Engineer with a tandem roller or vibratory roller meeting the approval of the Engineer. The bituminous mixture not subjected to traffic shall be compacted to the satisfaction of the Engineer.

408.04 Method of Measurement. Bituminous priming material will be measured for payment as specified in Section 1009.

Aggregate for covering the prime coat will be measured for payment in metric tons (tons) on platform scales meeting the approval of the Engineer.

Incidental bituminous surfacing will be measured for payment in metric tons (tons) on approved platform scales, and will include only those aprons which are constructed as a separate operation. Aprons placed with extendible screed wideners will be considered an integral part of mainline paving and will not be measured for payment as Incidental Bituminous Surfacing.

| Preparation of base will be measured according to Article 358.06.

408.05 Basis of Payment. This work will be paid for at the contract unit price per metric ton (ton) or per liter (gallon) for BITUMINOUS MATERIALS (PRIME COAT), at the contract unit price per metric ton (ton) for AGGREGATE (PRIME COAT), and at the contract unit price per metric ton (ton) for INCIDENTAL BITUMINOUS SURFACING.

| Preparation of base will be paid for according to Article 358.07.

PORTLAND CEMENT CONCRETE PAVEMENTS AND SIDEWALKS**SECTION 420. PORTLAND CEMENT CONCRETE PAVEMENT**

420.01 Description. This work shall consist of a pavement composed of portland cement concrete with or without reinforcement, constructed on a prepared subgrade, or subbase, with or without forms.

420.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Portland Cement Concrete	1020
(b) Concrete Reinforcement Bars, Fabric and Strands (note 1)	1006.10
(c) Pavement Longitudinal Metal Joints, Dowel Bars, Expansion Joint Assembly, and Contraction Joint Assembly (note 1).....	1006.11
(d) Poured Joint Sealer	1050
(e) Preformed Expansion Joint Filler	1051.08, 1051.09
(f) Protective Coat	1023.01
(g) Preformed Elastomeric Compression Joint Seals for Concrete	1053.01
(h) Non-Shrink Grout	1024.01
(i) Chemical Adhesive	1027.01

Note 1. All tie bars, dowel bars, reinforcement bars, and chair supports shall be epoxy coated. Chair supports for pavement fabric will not require epoxy coating.

420.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Forms for Pavement	1103.05
(b) Formless Paver	1103.16
(c) Form Grader	1103.06
(d) Water Supply Equipment	1103.11
(e) Batching and Weighing Equipment	1103.02, 1103.03
(f) Concrete Mixers	1103.01
(g) Truck Agitator and Nonagitator Truck	1103.01
(h) Heavy Subgrade Template	1103.10
(i) Mechanical Form Tamper	1103.07
(j) Mechanical Concrete Spreader	1103.12
(k) Finishing Machine	1103.13
(l) Mechanical Longitudinal Float	1103.15
(m) Concrete Finisher Float	1103.14
(n) Vibrators	1103.12
(o) Miscellaneous Equipment	1103.17
(p) Membrane Curing Equipment	1101.09
(q) Subgrade Planer	1103.08
(r) Subgrade Machine	1103.09
(s) Pavement Surface Test Equipment	1101.10

CONSTRUCTION REQUIREMENTS

420.04 Reserved.

420.05 Preparation of Subgrade or Subbase. The subgrade or subbase shall be graded, compacted, trimmed, and finished according to Sections 301, except Articles 301.04 and 301.05 will not apply, and Sections 302, 310, 311, or 312 will apply as appropriate. The minimum width of the prepared subgrade or subbase shall be according to the cross sections as shown on the plans.

420.06 Forms and Form Setting. Prior to the start of paving, forms shall be in place to accommodate at least one day's paving. Forms shall be clean and meet the requirements of Article 1103.05 prior to being set. Forms not meeting these requirements shall not be used. Forms shall be staked in place with at least three pins per 3 m (10 ft) section of form. Form sections shall be locked together. The forms shall be supported for the full length and width of the form line by either the subgrade or subbase. If required by the Engineer, the subbase or subgrade shall be tamped under the form line. The alignment of the form line shall be within a tolerance of ± 5 mm (1/4 in.) with the plan edge of pavement. The elevation of the form shall be the plan elevation of the edge of pavement. Minor deviations in the subgrade or subbase elevation may be corrected by placing compacted granular or subbase material in 10 mm (1/2 in.) lifts or less for low areas, provided the build up is not continuous. Shims or wedges shall not be used to build up the form line. High areas may be corrected by tamping or trimming as required. The minimum form height shall equal the plan pavement thickness. Form heights exceeding the pavement thickness may be used provided the forms are set and maintained at the plan elevation.

420.07 Placing. No concrete shall be mixed, placed or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated. Concrete shall not be placed on soft, muddy, or frozen subgrade or subbase. Concrete shall not be placed when the subgrade is frozen under permanent adjacent pavement. The concrete shall be unloaded into an approved mechanical concrete spreader and deposited uniformly across the subgrade or subbase as close as possible to its final position. The use of a mechanical spreader may be waived provided the concrete hauling equipment is equipped with a discharge system capable of distributing the concrete uniformly without segregation across the subgrade or subbase and meets the approval of the Engineer or a finishing machine meeting the requirements of the third paragraph of Article 1103.13 is utilized and satisfactory results are obtained. When required, hand spreading shall be accomplished with shovels. Paving shall be continuous between transverse joint locations shown on the plans. Transverse joint assemblies shall be protected from displacement or damage during the placement and consolidation of the concrete. Workers will not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

When approved in writing by the Engineer, pavements in excess of 7.2 m (24 ft) or more in width may be constructed full width in a single operation.

Where concrete is to be placed adjoining a previously constructed lane of pavement, and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained the strength specified for 14 day concrete.

If only finishing equipment is operated on the edge of the existing lane, paving in adjoining lanes may be permitted after three days.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

420.08 Reserved.

420.09 Strike Off of Concrete and Placement of Reinforcement Following placing, the concrete shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. Bends or kinks in individual wires, or other irregularities, shall be corrected before the sheet is laid in the pavement. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off and screeded. Any portion of the bottom layer of concrete which has been placed more than 20 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement shall be positioned on chair supports spaced at maximum intervals of 1.2 m (4 ft) in advance of concrete placement. The pavement reinforcement shall be placed such that the reinforcement in the completed pavement will be at the location shown on the plans with a placement tolerance for individual bars or individual wires of ± 25 mm (± 1 in.) horizontally and vertically.

Reinforcing steel shall be free from dirt, oil, paint, grease, or other materials which could impair bond with the concrete. All laps between sheets shall be held firmly together by wire or clips spaced not more than 1.2 m (4 ft) apart.

420.10 Joints. Joints shall be constructed of the type and dimensions, and at the locations required by the contract.

- (a) **Longitudinal Sawed Joint.** Epoxy-coated deformed steel tie bars of specified length, size, spacing and material shall be placed perpendicular to the longitudinal sawed joints. They shall be placed by approved mechanical equipment, firmly supported on support pins, or rigidly supported on approved joint assemblies to prevent displacement.

Longitudinal sawed joints shall be constructed along the centerline of two-lane pavements and along the lane lines of pavements paved more than two-lanes full width in a single operation.

Longitudinal sawed joints shall be formed by cutting the surface of the pavement by means of approved concrete saws to the depth, width and line shown on the plans. Suitable guidelines or devices shall be used to assure

cutting of the longitudinal joint on the true line as shown on the plans. Sawing of the longitudinal joint shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually four to 24 hours. All joints shall be sawed to the full depth as shown on the plans before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night regardless of weather conditions.

When multiple lane pavement is being placed in more than one operation, all required sawing of longitudinal joints shall be performed on the pavement in place before additional lanes are constructed. Sawing of a longitudinal joint shall be continuous across all transverse joints. Whenever sawing is discontinued, the cut shall terminate at a transverse joint. Water supply equipment for the sawing operations may be permitted on the pavement provided individual axle loads do not exceed 18 kN (4000 lb) and wheel loads are not applied within 1.8 m (6 ft) of the pavement edges.

- (b) Longitudinal Construction Joint. When adjacent lanes of pavement are constructed separately, epoxy-coated deformed steel tie bars of specified length, size, spacing and material shall be placed across the longitudinal construction joint to tie the lanes together. The epoxy-coated tie bars shall be installed in preformed or drilled holes along the vertical edge of the first lane placed as specified on the plans. The tie bars shall be installed with an approved non-shrink grout or chemical adhesive to provide a minimum pull requirement of 1) 35 kN for No. 15 bars (7750 lb for No. 5 and 5000 lb for No. 4 bars); 2) 49 kN (11,000 lb) for No. 20 (No. 6) bars; 3) 88 kN (19,750 lb) for No. 25 (No. 8) bars. Holes shall be blown clean and dry prior to placing the grout or adhesive. The installation shall be with methods and tools conforming to the grout or adhesive manufacturer's recommendations. The Contractor shall load test five percent of the first 500 tie bars installed. No further installation will be allowed until the initial five percent testing has been completed and approval to continue installation has been given by the Engineer. Testing will be required for 0.5 percent of the bars installed after the initial 500. For each bar that fails to pass the minimum requirements, two more bars selected by the Engineer shall be tested. Each bar that fails to meet the minimum load requirement shall be reinstalled and retested. The equipment and method used for testing shall meet the requirements of ASTM E 488. All tests shall be performed within 72 hours of installation. The tie bars shall be installed and approved before concrete is placed in the adjacent lane.

In lieu of the above, the tie bar may be formed in place provided the bar length is increased to 750 mm (30 in.) and is maintained in the proper location. Bending of the bar will not be allowed.

The sealant reservoir may be formed by sawing after the concrete has set as specified in (a) for longitudinal sawed joints, or it may be formed by hand tools when the concrete is in a plastic state.

- (c) Transverse Expansion Joints. Load transfer devices shall be installed according to Article 420.10(e). The expansion joint filler shall be continuous from form to form, and shaped to the subgrade or subbase. Preformed joint

filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than 5 mm (1/4 in.) in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

- (d) Transverse Contraction Joints. Transverse contraction joints shall consist of planes of weakness created by cutting grooves in the surface of the pavement and shall include load transfer devices. Sawed contraction joints shall be created by sawing grooves in the surface of the pavement, of the dimensions and at the spacing and lines shown on the plans, with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly cleaned.

Sawing of the joint shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually four to 24 hours. All joints shall be sawed to the full depth before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions.

Curing covering shall be removed from the pavement only at the location where a joint is to be cut. Only sufficient covering shall be removed to provide the necessary room for working at the location of the joint. As soon as the joint has been cut, the covering shall be replaced. In no case shall the top surface and edges of the pavement be left unprotected for a period of more than 1/2 hour.

Water may be sprayed on the saw blade during the cutting. If necessary, a suitable stationary guide shall be used to prevent side swaying of the machine to ensure that the cut will be straight. Water shall be used, if necessary, to thoroughly clean the joint. All extraneous material, including free water, shall be removed from the joint opening by means of an air jet.

Widening of the sawed joint for transverse contraction joints that are to receive a preformed elastomeric compression joint seal shall be performed as a separate operation at a later date according to the provisions of Article 420.14(b).

- (1) When contraction joints are to be sealed with poured joint sealant according to Article 420.14(a) the sawing of any joint shall be omitted if an uncontrolled crack occurs within 75 mm (3 in.) of either side of the joint prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. Uncontrolled cracks within these limits will be considered an acceptable joint provided the uncontrolled crack is routed, cleaned, and sealed according to Section 452, at the Contractor's expense. All contraction joints in lanes adjacent to

previously constructed lanes shall be sawed before uncontrolled cracking occurs.

If an uncontrolled crack develops on one side of the contraction joint, more than 75 mm (3 in.) from the joint and less than 1.8 m (6 ft) from the same joint, a minimum of 1.8 m (6 ft) of pavement removal and replacement will be required. Removal and replacement of the pavement shall be done at the Contractor's expense. If cracking occurs on both sides of the joint, more than 75 mm (3 in.) from the joint, the dowel bar assembly and a minimum of 1 m (3 ft) of pavement each side of the joint shall be removed and replaced. Removal and replacement of the pavement shall be done at the Contractor's expense.

If an uncontrolled crack develops on one side of the contraction joint in the mid panel area between 1.8 m (6 ft) from the joint and the midpoint of the panel, the entire panel shall be replaced on that side of the joint within the lane containing the cracking. Removal and replacement of the pavement shall be done at the Contractor's expense.

No section of pavement less than 1.8 m (6 ft) in length will be allowed to remain in place.

The Department will provide drawings and specification of repair procedures to the Contractor. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed in a manner approved by the Engineer prior to initial set of the concrete.

- (e) Load Transfer Devices. Dowels, when used, shall be held in position parallel to the surface and centerline of the slab by metal devices that meet the approval of the Engineer.

A light coating of oil shall be uniformly applied to the bars prior to placing the concrete. The welds in the assembly shall be securely made. A broken weld will be sufficient cause for the rejection of the length or section of the assembly in which it occurs.

The dowel bar assembly shall be completely assembled before being placed in position. The assembly shall be installed so that the dowel bars are parallel to the proposed pavement surface and to each other and so that the assembly is at right angles to the centerline of the pavement. All shipping tie wires shall be cut after the assembly is secured in place. At the location of each dowel bar assembly, the subgrade or subbase shall be reshaped and re-tamped when necessary.

When the dowel bar assembly is in place on the subgrade or subbase, the assembly shall act as a rigid unit with each component part securely held in position relative to the other members of the assembly. The entire assembly shall be held securely in place during placing, consolidating, and finishing of the concrete, by means of nails which shall penetrate the stabilized subbase. At least ten nails shall be used for each 3, 3.3, or 3.6 m (10, 11, or 12 ft) section of assembly. Bearing plates shall be punched to receive the

nails. Metal stakes shall be used instead of nails, with soil or granular subbase, and shall penetrate the subbase at least 300 mm (12 in.).

The Contractor shall check the horizontal alignment of the dowel bars by an approved means and the vertical alignment of each dowel bar by means of a leveling device so constructed that it may be adjusted to the correct grade. Any deviation from correct alignment greater than 3 mm (1/8 in.) in 300 mm (12 in.) shall be corrected before any concrete is placed.

Care shall be exercised in depositing the concrete at the dowel bar assemblies so that the horizontal and vertical alignment will be retained.

The sawing of all joints shall be included in the cost of the particular pavement item in which it is installed.

- (f) Transverse Construction Joints. Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. The transverse construction joint shall be formed by means of a suitable header, accurately set and securely held in place in a plane perpendicular to the surface of the pavement.

When the pavement is constructed with pavement fabric reinforcement, no transverse construction joint shall be constructed within 3.0 m (10 ft) of a contraction joint. The construction joint shall conform to the details shown on the plans, except that if sufficient concrete has not been mixed at the time of interruption to form a slab extending at least 3.0 m (10 ft) beyond the last contraction joint, the excess concrete back to the last preceding joint shall be removed and disposed of as directed by the Engineer and the construction joint shall be constructed as a contraction joint.

420.11 Final Strike Off, Consolidation, and Finishing. The sequence of operations shall be the strike off and consolidation, screeding, longitudinal floating, straightedging, edging and final finish.

The consolidation and finishing operations shall at all times be such as to produce a satisfactory surface. If this provision is not being complied with, the paving operations will be stopped by the Engineer and the Contractor will not be permitted to proceed until satisfactory results are assured.

All portland cement concrete pavement shall be vibrated with a surface pan type vibrator or internal vibrator approved by the Engineer. Vibrators shall not come in contact with a joint assembly, the grade or side forms. Vibration of the concrete shall not exceed ten seconds at any one location.

- (a) Finishing. The following methods of finishing concrete shall be used:

- (1) Vibratory Method. After the concrete has been struck off, the concrete shall be vibrated for the full width of the concrete pavement. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and methods which will produce pavement conforming to the Specifications.

The Contractor shall have a satisfactory tachometer available for checking the operating frequency of the vibrating elements.

The concrete shall be distributed or spread with an approved mechanical spreader as soon as placed. As soon as the concrete has been spread and consolidated, it shall be screeded by an approved finishing machine. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without lift, wobbling or other variations tending to affect a uniform finish. If the rate of depositing concrete is in excess of the amount which the finishing machine can strike off and consolidate, a second finishing machine shall be provided and used.

- (2) Hand Finishing. Hand finishing methods will not be permitted except in the event of breakdown of the mechanical equipment. Hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.
- (3) Vibrating Screed. An approved vibrating screed may be used to strike off and consolidate variable width pavement, pavement less than 3 m (10 ft) in uniform width and paving gaps at driveways, intersections, etc. The vibration shall be shut off whenever forward motion of the screed is stopped. The vibrating screed for the surface shall be at least 600 mm (2 ft) longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape and be constructed either of metal or of other suitable material shod with metal.

In operation, the vibrating screed shall be moved forward on the forms, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

- (b) Longitudinal Float Method. Required for all mainline pavement with a posted speed limit of 65 km/hr (40 mph) or more. After the concrete has been struck off and consolidated, it shall be further smoothed and trued, by means of an approved float, using one of the following methods.
 - (1) Mechanical Longitudinal Float Method. The mechanical longitudinal float shall be of a design approved by the Engineer, and shall be in good working condition. It shall be equipped with a power driven floating screed and shall oscillate longitudinally with respect to the pavement during its transverse travel across the pavement. It may be either attached to the finishing machine or formless paver, self propelled on rollers operating on forms or self propelled operating on tracks. If attached to a finishing machine or formless paver, it shall be rigidly supported by a frame at the rear in a manner approved by the Engineer. If self propelled, the tracks or rollers from which the float operates shall be in good working condition. The tracks or rollers from which the float operates shall be accurately adjusted and coordinated with the

adjustments of the finishing machine or formless paver so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by the Engineer on each transverse trip. The float shall pass over each area of pavement at least two times, but excessive operation over a given area will not be permitted. Excess water or soupy material shall be wasted over the side on each pass.

- (2) Concrete Finisher Float Method. The Contractor may use a machine, after approval by the Engineer, composed of a smoothing float or floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more wheels riding on, and constantly in contact with, the side forms.
- (3) Hand Method. This method may only be used in an emergency or if specified. The hand-operated longitudinal float shall be not less than 3 m (10 ft) in length and properly stiffened to prevent flexibility and warping during the finishing operation. The handle shall be not less than 1 m (3 ft) longer than 1/2 the width of the slab. The float shall be used parallel to the road centerline and passed gradually from one side of the pavement to the other to fill depressions or cut down high areas. Movement ahead along the centerline of the pavement shall be in successive advances of not more than 1.5 m (5 ft). Any excess mortar shall be wasted over the side forms on each pass. Floating shall continue until the entire surface is found to be free from variations and the slab conforms to the required grade and cross section.

If necessary, following one of the preceding methods of floating, long handled floats having blades not less than 900 mm (3 ft) in length and 150 mm (6 in.) in width may be used to smooth and fill in open-textured areas in the pavement, but shall not be used to float the entire surface of the pavement in lieu of, or supplementing one of the preceding methods of floating.

- (c) Straightedge Testing and Surface Correction. After the floating has been completed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a 3 m (10 ft) straightedge. For this purpose, the Contractor shall furnish and use an accurate 3 m (10 ft) straightedge which has a handle not less than 1 m (3 ft) longer than 1/2 the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the road centerline and the whole area gone over from one side of the slab to the other. Advance along the road shall be in successive stages of not more than 1/2 the length of the straightedge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing of the surface shall continue until the entire surface is found to be free from variations from the straightedge, and the slab conforms to the required grade and cross section.

If the hand method using a 3 m (10 ft) longitudinal float is permitted and surface corrections made as specified in Article 420.11(b), straightedge testing will not be required.

- (d) Edging. After longitudinal floating, straightedging, and before the final finish, the edges of the pavement shall be carefully finished with an edging tool having a radius of not more than 6 mm (1/4 in.) and the pavement edge left smooth and true to line.
- (e) Final Finish. Type A final finish shall be used unless Type B is specified.
 - (1) Type A. Type A final finish shall be obtained by the use of a carpet drag composed of an artificial turf approved by the Engineer followed immediately by a mechanically operated metal comb transverse grooving device.

The artificial turf shall be made of molded polyethylene with synthetic turf blades approximately 20 mm (0.85 in.) long and contain approximately 7,200 individual blades per 0.1 sq m (sq ft). The artificial turf shall be suitably attached to an approved device that will permit control of the time and rate of texturing. The artificial turf carpet shall be full pavement width and of sufficient size that during the finishing operation, approximately 600 mm (2 ft) of carpet parallel to the pavement centerline will be in contact with the pavement surface. The drag shall be operated in a longitudinal direction so as to produce a uniform appearing finish meeting the approval of the Engineer. If necessary for maintaining intimate contact with the pavement surface, the carpet may be weighted.

The metal comb shall consist of a single line of tempered spring steel tines spaced at 20 mm (3/4 in.) centers and securely mounted in a suitable head. The tines shall be flat and of a size and stiffness sufficient to produce a groove of the specified dimensions in the plastic concrete without tearing of the pavement edge or surface. The Contractor shall modify the equipment or operations if an acceptable pavement edge or surface is not produced. The mechanically operated metal comb shall be attached to an exclusive piece of equipment which is mechanically self-propelled and capable of traversing the entire pavement width being placed in a single pass. The artificial turf carpet drag may be attached to this piece of equipment provided a surface texture is produced satisfactory to the Engineer. The tining device shall be operated so as to produce a relatively uniform pattern of grooves perpendicular to the pavement centerline spaced at approximately 20 mm (3/4 in.) centers, 3 to 5 mm (1/8 to 3/16 in.) deep and 2.5 to 3.2 mm (0.100 to 0.125 in.) wide. No other operation will be permitted with this equipment. Separate passes will be required for the turf dragging operation and the tining operation.

Hand tining or tining with a mechanically operated comb combined with the curing equipment specified in Article 1101.09 will be permitted where the Specifications permit hand finishing or vibratory screeds, one lane construction up to 5 m (16 ft) wide, gaps, projects with a net length

of 800 m (1/2 mile) or less, and where the production rate on any paving day will be less than 1200 cu m (1,500 cu yd) per day. A foot bridge shall be provided for the hand tining operation for all pavement over 3.6 m (12 ft) wide, unless it can be demonstrated to the satisfaction of the Engineer that an alternate texturing operation produces satisfactory results.

Pavement texture not meeting the above spacing and depth requirements shall be corrected by the Contractor at his/her own expense. Regrooving in either plastic or hardened concrete shall be done transversely meeting the spacing and depth requirements as stated above.

- (2) Type B. Type B final finish shall be obtained by the use of a single artificial turf drag. The artificial turf shall conform and be operated according to the requirements for Type A finish, except this device shall not be attached to other pieces of equipment in the paving train but shall be a separate piece of equipment used expressly for the texturing operation. Pavement texture damaged by rain may be restored by retexturing the concrete while in the plastic state.

420.12 Surface Tests. The surface of the finished pavement shall be tested and be within the tolerances specified in Article 407.09 and as follows:

Testing with a profilograph for the first several days of paving following initial start up or after a long shutdown period shall be performed as soon as the concrete has cured sufficiently to permit the testing.

When the average profile index for the entire project length does not exceed 67 mm/km (4.25 in./mile), and no 160 m (0.1 mile) section has a profile index exceeding 160 mm/km (10 in./mile), the contract unit price shall be increased according to the following Price Adjustment Schedule. When the profile index for a 160 m (0.1 mile) section does not exceed 160 mm/km (10 in./mile) payment will be made at the contract unit price for that section. When the profile index for a 160 m (0.1 mile) section exceeds 160 mm/km (10 in./mile) but does not exceed 235 mm/km (15 in./mile) the contract unit price for that section will be reduced according to the following Price Adjustment Schedule.

PRICE ADJUSTMENT SCHEDULE

<u>Profile Index for Entire Project</u> <u>mm/km (in./mile)</u>	<u>Percent of Unit Bid Price</u>
36 (2.25) or less	103
over 36 (2.25) to 53 (3.25)	102
over 53 (3.25) to 67 (4.25)	101
 <u>Profile Index for 160 m (0.1 mile)</u> <u>Section, mm/km (in./mile)</u>	 <u>Percent of Unit Bid Price</u>
over 67 (4.25) to 160 (10)	100
over 160 (10) to 175 (11)	98
over 175 (11) to 190 (12)	96
over 190 (12) to 205 (13)	94
over 205 (13) to 220 (14)	92
over 220 (14) to 235 (15)	90
over 235 (15)	Corrective work required

Membrane curing damaged during the testing operations shall be repaired by the Contractor, at his/her own expense, as directed by the Engineer.

On all areas where corrective grinding is done, the Contractor shall apply, at his/her own expense, a protective coat according to Article 420.21.

Curing and protective covers if used, shall be removed from the pavement for the required profilograph and straightedge measurements and properly replaced when the testing is completed according to Article 1020.13(b).

420.13 Removing Forms. Forms shall not be removed from freshly placed concrete until it has set for at least 12 hours, except auxiliary forms used temporarily in widened areas. Forms shall be removed carefully avoiding damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated in Article 1020.13.

Any honeycombed or porous areas shall be corrected as directed by the Engineer. Effective surface drainage shall be provided and maintained to prevent the accumulation of water along the edges of the pavement. Underwash along the edges shall be prevented, where grades are such as to cause this action, by placing earth against the edges to the full height of the slab.

420.14 Sealing Joints. Joints shall be sealed, as shown on the plans, before the pavement is opened to traffic, including construction traffic, and as soon after the curing period as feasible.

- (a) **Poured Joint Seal.** Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and the joint faces shall be clean and surface dry when the seal is applied. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur.

The sealing material shall be applied to each joint opening to conform to the details shown on the plans or as directed by the Engineer. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete.

Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned. The use of sand or similar material as a cover for the seal will not be permitted. Poured joint sealing material shall not be placed when the air temperature in the shade is less than 10 °C (50 °F), unless approved by the Engineer.

When sand is to be placed for the joint filler prior to sealing expansion joints with a hot-poured joint sealer, the sand shall be a dry, durable sand with 100 percent passing the 4.75 mm (No. 4) sieve and no more than three percent passing the 75 µm (No. 200) sieve when tested according to AASHTO T 11.

420.15 Protection of Pavement. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's own employees and agents. This shall include flaggers to direct traffic and the erection and maintenance of standard warning signs, lights, pavement bridges or crossovers. Earth berms shall be constructed along each edge to the full height of the pavement, and of such width as to reduce traffic hazard, yet will not impound water on the pavement surface.

Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced in a manner acceptable to the Engineer by the Contractor at his/her own expense.

420.16 Opening to Traffic. The road shall be opened to traffic according to Article 701.05(c)(6).

420.17 Slip Form Method. At the option of the Contractor, slip form paving methods may be used for construction of the pavement.

The slip form paving machine shall be approved by the Engineer prior to starting the paving operations. It shall be self-propelled and be designed for the specific purpose of placing, consolidating and finishing concrete pavement slabs true to grade and cross section in one complete pass without the use of fixed side forms. The machine shall be equipped with means for spreading the concrete to a uniform depth before it enters the throat of the machine. The machine shall vibrate the concrete either externally or internally with sufficient intensity to consolidate the concrete throughout its entire depth and width.

All paving equipment, including the spreader, paver, float, texturing machine and curing machine shall ride on the stabilized subbase. The subbase shall be constructed to a width 150 mm (6 in.) wider than the width from outside-to-outside of the slip form paver's tracks.

The slip form paving equipment shall spread, consolidate, screed and float finish the freshly placed concrete in one pass in a manner such that a minimum of hand floating will be required. The operations of depositing, spreading, consolidating, and

finishing shall be a continuous operation of the paver as much as possible. Frequent starting and stopping of the paver shall be kept to a minimum.

Final finish shall be obtained as specified in Article 420.11(e).

Curing of the surface and edges shall be done according to one of the methods specified in Article 1020.13.

In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than 25 mm (1 in.) and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or curing paper for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

The surface of the completed pavement shall be within the tolerance specified in Article 420.12, except that a tolerance will be permitted for edge slump, exclusive of edge rounding.

Uplift of the outer edge of slip-formed pavement will not be allowed and shall be corrected if it occurs before the concrete has hardened to allow for cross slope drainage. If operational adjustments cannot correct the uplift, the paving operations will be suspended until the equipment is properly repaired.

Edge slump will be measured by placing a 1.2 m (4 ft) straightedge perpendicular to the centerline of pavement and taking the vertical measurement at the edge of the completed pavement where the normal edge rounding begins. The following edge slump tolerances will be allowed:

- (a) Edge slump of the concrete pavement, exclusive of edge rounding, may vary up to 13 mm (1/2 in.) at locations where no additional concrete work is to be constructed immediately adjacent to the pavement being placed. Edge slump will be tested as soon as practical after paving operations begin. Any edge settlement in excess of 13 mm (1/2 in.) shall be corrected before the concrete has hardened. When edge settlements in excess of 13 mm (1/2 in.) persist, paving will be suspended and operational corrections shall be made before the Engineer will permit the resumption of paving. If the Contractor consistently fails to construct pavement within these specified tolerances, the use of slip form methods will be discontinued and the pavement shall be placed by means of conventional forms.
- (b) Edge slump of the concrete pavement in excess of 6 mm (1/4 in.) will not be allowed at locations where additional concrete work (widening, ramps, additional lanes, curb and gutter, etc.) is to be constructed immediately adjacent to the pavement being placed. The Contractor shall correct any edge settlement in these areas before the concrete has hardened. If the concrete has hardened, edge slump shall be corrected by removing no less

than 3 m (10 ft) in length of defective pavement full depth and replacing the pavement as part of the adjacent widening, ramps, additional lanes, curb and gutter, etc. All pavement removed for edge slump shall be sawed full depth longitudinally for a width not to exceed 300 mm (1 ft). The transverse saw cuts and reinforcement replacement shall be as provided in Article 442.06. The pavement shall be carefully removed and No. 25 (No. 8) epoxy-coated deformed reinforcement bars 600 mm (24 in.) long shall be grouted in place in holes drilled at mid-depth on 750 mm (30 in.) centers along the pavement edge. Variations in the edge of pavement that cannot be corrected by removing 300 mm (1 ft) off the side of the lane shall be removed a full lane width. All full lane width removal and replacement shall be done according to Section 442 and shall be at least 3 m (10 ft) in length. This work shall be done at the Contractor's expense and no additional compensation will be allowed. If edge slump is a continuous problem in areas contiguous to adjacent concrete work, the concrete shall be placed and finished either as required for standard paving methods or by use of false forms placed adjacent to the slip formed pavement edge. The false forms shall be of sufficient thickness to maintain the proper shape and continuity of the form line and will be approved by the Engineer. Bracing of the forms shall be such that at no time will there be more than 3 m (10 ft) of unbraced false forms. False forms shall remain in place for at least 90 minutes, or for a longer period of time as directed by the Engineer when their removal is apt to cause injury to the adjacent concrete.

420.18 Tolerance in Thickness. Determination of pavement thickness and computation of thickness and requirements relative to deficient thickness shall be as specified in Article 407.10, except that the width of a pavement unit shall be the width from the pavement edge to the adjacent longitudinal joint, from one longitudinal joint to the next, or between pavement edges where there is no longitudinal joint.

420.19 Bridge Approach Pavement, Shoulder Pavement And Connectors. When the plans require the construction of special reinforced pavement or shoulder pavement at bridge approaches, all reinforcement bars shall be placed according to Article 421.06(a). All reinforcement shall be lapped 24 diameters. If the bridge approach pavement connector is specified to be flexible pavement, it shall be constructed according to the applicable portions of Section 407. The concrete shall be consolidated and finished according to Article 420.11 and with equipment meeting the requirements of Article 1103.13(b) or Article 1103.17(g).

420.20 Adjacent to Railroad Grade Crossing. Portland cement concrete pavement adjacent to railroad grade crossings shall be constructed according to the details shown on the plans except that when the mainline portland cement concrete pavement thickness is greater than 250 mm (10 in.), the thickness of the slab adjacent to the railroad crossing shall be increased to the same thickness as the mainline.

The No. 25 (No. 7) reinforcement bars in the slab adjacent to the railroad crossing shall be lapped a minimum of 650 mm (26 in.). A longitudinal construction joint will be permitted in lieu of the sawed longitudinal joint when stage construction is used.

The bituminous plug shall be constructed of bituminous concrete binder course mixture according to the applicable requirements of Section 406. At the Contractor's option, Class I bituminous concrete surface course mixture may be used in lieu of the binder course mixture.

420.21 Protective Coat Application. When pavement is constructed after October 15 and it will be opened to traffic prior to the following April 15, or when directed by the Engineer, two coats of protective coat shall be applied to the surface of the pavement and appurtenances, when the concrete is at least 14 days old and before the pavement is marked and opened to traffic.

Before the protective coat is applied, the concrete surface shall have at least a 48-hour drying period since the last rain and shall be cleaned to remove all oil, grime and loose particles which would prevent the mixture from penetrating the concrete.

The rate of application for each coat shall be not more than 11 sq m/L (50 sq yd/gal) of mixture.

The protective coat shall be sprayed on the surface with a mechanical spraying machine which will perform the work in a satisfactory manner. The spray nozzles shall be within 450 mm (18 in.) of the concrete or as directed by the Engineer. The interior of the distributor tank shall be thoroughly cleaned prior to placing the protective coat therein. Unless otherwise directed by the Engineer, the temperature of the concrete and air shall be 10 °C (50 °F) or higher at the time of application.

The second application of the protective coat shall not be made until the concrete, in the opinion of the Engineer, has regained its dry appearance.

CAUTION: As linseed oil - petroleum spirits mixture has a low flash point and is readily flammable, fire of all sorts, including cigarettes and sparks, shall be carefully guarded against. Traffic shall be prohibited from the area until the concrete has regained its dry appearance.

If an application of sand is required by the Engineer for blotter material, it will be paid for according to in Article 109.04.

420.22 Method of Measurement.

- (a) **Contract Quantities.** The requirements for the use of contract quantities shall conform to Article 202.07(a).
- (b) **Measured Quantities.** Portland cement concrete pavement, bridge approach pavement, bridge approach shoulder pavement and bridge approach pavement connectors will be measured for payment in place and the area computed in square meters (square yards). The length will be measured along the centerline of the surface of each roadway, ramp, or approach pavement. The width will be the width of pavement as shown on the plans. In computing the area for payment for bridge approach pavement and bridge approach shoulder pavement, a deduction will be made for the area displaced by the inlet.

Reinforcement bars used in portland cement concrete pavement adjacent to railroad grade crossings will be measured for payment in kilograms (pounds) as specified in Article 508.07.

The quantity of pavement fabric will be the computed surface area of the concrete pavement in which the pavement fabric is installed and no allowance will be made for laps, splices or portions of sheets not used. When the plan width of subbase is extended for the slip form method, such extended width will not be measured for payment but shall be considered as included in the unit price bid for the item of subbase involved.

The areas upon which the protective coat is applied, except where corrective grinding has been performed, will be measured for payment and computed in square meters (square yards).

Tie bars will be measured according to Article 508.07.

420.23 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for PORTLAND CEMENT CONCRETE PAVEMENT, HIGH- EARLY-STRENGTH PORTLAND CEMENT CONCRETE PAVEMENT, and PORTLAND CEMENT CONCRETE PAVEMENT (JOINTED), of the thickness specified; at the contract unit price per square meter (square yard) for BRIDGE APPROACH PAVEMENT; at the contract unit price per square meter (square yard) for PORTLAND CEMENT CONCRETE BRIDGE APPROACH SHOULDER PAVEMENT, BRIDGE APPROACH PAVEMENT CONNECTOR (Portland Cement Concrete), or BRIDGE APPROACH PAVEMENT CONNECTOR (FLEXIBLE); and at the contract unit price per square meter (square yard) for PAVEMENT FABRIC.

The unit price bid for Bridge Approach Pavement and PC Concrete Bridge Approach Shoulder Pavement shall include tie bars, preformed joint seal, polyethylene bond breaker, granular subbase, reinforcement bars, the concrete pad (including reinforcement and excavation), and all other items necessary to complete this item of work.

The unit price bid for Bridge Approach Pavement Connector shall include tie bars, reinforcement and all other materials and items necessary to construct a complete connector of the type specified.

If pavement block-outs or round-outs are required, the added reinforcement for pavement block-outs or round-outs will not be paid for as a separate item, but shall be considered as included in the unit price bid for the pavement specified.

The unit price bid for Portland Cement Concrete Pavement, High-Early-Strength Portland Cement Concrete Pavement or Portland Cement Concrete Pavement (Jointed) shall include the cost of any added thickness of pavement adjacent the railroad grade crossings. The reinforcement bars used in the slab adjacent to railroad grade crossings will be paid for according to Section 508. The bituminous plug will be paid for at the contract unit price per metric ton (ton) for BITUMINOUS CONCRETE BINDER COURSE, CLASS I, TYPE 2, as specified in Section 406.

When the contract requires the Contractor to furnish a profilograph, the cost of furnishing a California type profilograph or approved equivalent, providing for its

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maintenance and jobsite transportation, furnishing the profile scale and bump template, profilograph paper and recorder pens as outlined above will be paid for at the lump sum price for FURNISH PROFILOGRAPH.

The cost of furnishing a 5 m (16 ft) straightedge and providing for its job site transportation shall be considered as included in the various items involved and no additional compensation will be allowed.

If a protective coat is applied other than at locations where corrective grinding has been performed, it will be paid for at the contract unit price per square meter (square yard) for PROTECTIVE COAT, which price will be payment in full for cleaning the surface of the pavement and appurtenances and for the two applications.

Removing and replacing curing and protective cover, when required, will be paid for according to Article 109.04.

SECTION 421. CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT

421.01 Description. This work shall consist of constructing a continuously reinforced portland cement concrete on a prepared subgrade or subbase.

421.02 Materials. Materials shall meet the requirements of Article 420.02. Wide flange beam shall meet the requirements of Article 1006.04 and be galvanized according to AASHTO M 111.

421.03 Equipment. Equipment shall meet the requirements of Article 420.03.

CONSTRUCTION REQUIREMENTS

421.04 General. Continuously reinforced concrete pavement shall be constructed according to the applicable portions of Articles 420.05 through 420.21 except as specified.

421.05 Placing. This work shall be performed according to Article 420.07 with the following exception:

When the pavement is to be struck off and consolidated according to Article 420.11(a)(2), the concrete adjacent to both side forms shall be consolidated with a vibrator to eliminate all honeycomb or porous areas in pavement edges. The vibrator shall be inserted into the concrete and worked along the entire length of the forms before the finishing operations are initiated.

421.06 Strike Off of Concrete and Placement of Reinforcement. This work shall be performed according to Article 420.09 with the following exceptions:

- (a) Placement of Reinforcement. The pavement reinforcement shall be placed such that the reinforcement in the completed pavement will be at the location shown on the plans with a placement tolerance for individual bars of ± 25 mm (± 1 in.) horizontally and vertically.

Reinforcement bars shall be tied securely together. The minimum length of longitudinal bars shall be 9 m (30 ft) except as required to establish the lap arrangement selected.

The Engineer will check the depth and lateral placement of the pavement reinforcement at such times and in such places as the Engineer may elect. No additional compensation will be allowed for replacing and refinishing concrete at inspection points.

Pavement reinforcement shall be supported on epoxy or plastic coated chairs at the depth below the pavement surface as indicated on the plans. The plastic chairs may be recycled plastic. The Contractor shall submit prints of shop drawings showing details of chairs and their spacing to the Engineer and obtain the Engineer's approval before any fabrication is begun.

The chairs shall possess the necessary rigidity and be spaced at intervals close enough to hold the reinforcement at the proper depth and position. However, the spacing of the chairs shall not exceed 900 mm (3 ft) transversely or 1.2 m (4 ft) longitudinally. The chairs shall be fabricated with sand plates.

Pavement reinforcement bars shall be assembled by fastening the longitudinal bars to the transverse bars with wire, clips, or other acceptable methods meeting the approval of the Engineer. The size and spacing of the bars shall be as shown on the plans. Welding of the longitudinal and transverse bars will not be permitted.

421.07 Joints And Concrete Lug End Anchorages. The longitudinal and transverse joints and lug end anchorages shall be constructed as specified in the contract according to Article 420.10 with the following exceptions:

- (a) Longitudinal Sawed Joints. The tie bars in longitudinal sawed joints shall be positioned on the prepared subbase prior to concrete placement and shall either be supported on approved assemblies or securely tied to the underside of the longitudinal bars of the pavement reinforcement.
- (b) Transverse Construction Joints. Transverse construction joints shall be made at the end of each day's run or when an interruption in the concreting operation of 30 minutes or more occurs, provided the length of pavement laid from the last joint is 4 m (12 ft) or more and the distance from the construction joint to the nearest bar-lap is at least 1.1 m (3 1/2 ft). Sections less than 4 m (12 ft) in length shall be removed by the Contractor at his/her own expense.

The transverse construction joint shall be formed by means of a suitable split header board conforming to the cross section of the pavement, accurately set and securely held in place in a plane perpendicular to the surface of the pavement. The pavement reinforcement bars shall extend continuously through the split in the header board and shall be supported beyond the joint by metal chairs. The header board shall be kept clean and shall not be oiled. Any excess mortar material accumulated at the front of the paver

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shall be wasted and not incorporated into the pavement at the joint. Before paving operations are resumed, the header board shall be removed, any concrete or mortar that may have leaked through the holes or split in the header shall be chipped from the face of the joint and removed, all surplus concrete on the subgrade or subbase shall be cleared away, and any irregularities in the subgrade or subbase shall be corrected. The fresh concrete shall be deposited directly against the old and shall be consolidated with a hand vibrator inserted into the concrete and worked along the entire length of the joint. Transverse construction joints shall not be edged or sealed.

When internal vibration is used for concrete consolidation, the pavement areas adjacent to both sides of transverse construction joint shall receive additional consolidation from hand vibrators inserted into the concrete and the surface shall be refinished. These areas shall extend at least 3 m (10 ft) from the joint.

- (c) **Transverse Terminal Joint.** When specified, transverse terminal joints shall be constructed at the ends of a construction section according to the details included in the plans. The concrete shall be either Class SI Concrete or Class PV Concrete. The pad shall be constructed to the same slope and cross section as the pavement and the entire top surface shall be given a smooth finish with a steel trowel. The concrete pad shall be completed and cured as specified in Article 1020.13 before the pavement and remainder of the transverse terminal joint is constructed.
- (d) **Wide Flange Beam Terminal Joint.** The sleeper slab shall be constructed of either Class SI Concrete or Class PV Concrete placed in a trench as shown on the plans. The sleeper slab shall be constructed to the same slope and cross section as the pavement. The top surface of the sleeper slab shall be given a smooth finish with a steel trowel on the pavement side of the steel beam and a rough finish on the terminal joint side. The sleeper slab shall be cured as specified in Article 1020.13(d)(1), except that membrane curing will not be permitted.

The chairs for the beams may be uncoated steel. When used, the uncoated chairs shall be at 1.8 m (6 ft) centers, beginning 900 mm (3 ft) from the end of the beam.

The concrete in the groove on the expansion side of the wide flange shall be carefully finished across the top and at the edges of the pavement to facilitate unrestrained pavement expansion.

- (e) **Lug End Anchorages.** The lugs shall be constructed in trench. Excavation for the trench shall be to the minimum dimensions shown on the plans. The use of forms will not be permitted. The lugs and the concrete pad above the lugs shall be constructed of either Class SI Concrete or Class PV Concrete and shall be cured as specified in Article 1020.13(d)(1) except that membrane curing will not be permitted. The surface of the concrete pad shall be finished rough and shall be free of any dust, dirt or other foreign material at the time the continuously reinforced concrete pavement is placed.

421.08 Final Strike Off, Consolidation and Finishing. The final strike off, consolidation and finishing shall be performed according to Article 420.11 with the following exceptions:

- (a) The vibrating impulse shall be applied in a manner to consolidate the concrete throughout its entire depth and width.
- (b) Special care shall be taken to attain thorough consolidation of the concrete under and around the lapped bars to avoid segregation and honeycomb.
- (c) The pavement vibrator shall not be allowed to operate for more than ten seconds while the machine is standing still. Only one pass of the vibratory equipment shall be made.

421.09 Thickness Tolerance. The tolerance in pavement thickness shall be according to Article 407.10, except that the width of a pavement unit shall be as specified in Article 420.18 and if any thin pavement is deficient in thickness by more than ten percent is left in place, the Contractor will receive no compensation for the thin pavement. In addition, an amount equal to four times the contract cost of the thin pavement will be deducted from the compensation due the Contractor.

421.10 Method of Measurement.

- (a) Contract Quantities. The requirements for the use of contract quantities shall conform to Article 202.07(a).
- (b) Measured Quantities. Continuously reinforced portland cement concrete pavement will be measured for payment in place and the area computed in square meters (square yards). The width will be the width of pavement as shown on the plans.

The quantity of reinforcement bars used for pavement reinforcement will be the computed square meters (square yards) of surface area of the pavement in which the pavement reinforcement is installed, and no allowance will be made for laps, splices or portions of bars not used. Expansion joints and extra reinforcement in the pavement over concrete pads, sleeper slabs and at construction joints will not be measured for payment but shall be included in the unit price bid for continuously reinforced portland cement concrete pavement.

When the plan width for subbase is extended for the slipform method, such extended subbase will not be measured for payment but shall be considered as included in the unit price bid for the item of subbase involved.

The pavement surfaces upon which the protective coat is applied, except where corrective grinding has been performed, will be measured for payment, and the areas computed in square meters (square yards).

421.11 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT and CONTINUOUSLY REINFORCED HIGH-

EARLY-STRENGTH PORTLAND CEMENT CONCRETE PAVEMENT, of the thickness specified, and PAVEMENT REINFORCEMENT.

Bridge Approach Pavement and Bridge Approach Pavement Connector will be paid for as specified in Article 420.23.

Wide flange beam terminal joints will be paid for at the contract unit price each for WIDE FLANGE BEAM TERMINAL JOINT COMPLETE of the pavement width specified, which price shall include all excavation, portland cement concrete, reinforcing bars, structural steel, pavement, pavement reinforcement, stabilized subbase and all other appurtenances necessary to construct the wide flange beam terminal joint complete as shown on the plans.

Lug anchor systems will be paid for at the contract unit price each for LUG SYSTEM COMPLETE of the pavement width specified, which price shall include all excavation, portland cement concrete, reinforcement and all other appurtenances necessary to construct the lug system complete as shown on the plans. The continuously reinforced portland cement concrete pavement over the lugs will be paid for as specified above.

Transverse terminal joints will be paid for at the contract unit price each for TRANSVERSE TERMINAL JOINT COMPLETE of the pavement width specified, which price shall include the reinforced concrete pad (including excavation), header board, wood blocking and extended reinforcement beyond the end of the pavement.

If a protective coat is applied, it will be paid for at the contract unit price per square meter (square yard) for PROTECTIVE COAT, which price shall be payment for cleaning the surface of the pavement and appurtenances and for the two applications.

Removing and replacing curing and protective cover, if required, will be paid for according to Article 109.04.

When the contract requires the Contractor to furnish a profilograph, the profilograph and 5 m (16 ft) straightedge will be paid for according to Article 420.23

SECTION 422. PORTLAND CEMENT CONCRETE RAILROAD CROSSING

422.01 Description. This work shall consist of constructing a cast-in-place portland cement concrete railroad crossing constructed in two courses on a prepared subgrade.

The removal and replacement of ballast, rails, ties, tie plates and fastenings; the surfacing and lining of track to true line and grade; and the furnishing and placing of the inner guardrails will be executed by others without charge to the Contractor.

422.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Reinforcement Bars	1006.10
(b) Portland Cement Concrete	1020
(c) Bituminous Materials	1009.01, 1009.04, 1009.08
(d) Preformed Joint Filler	1051
(e) Protective Coat	1023.01

422.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Concrete Mixers	1103.01
(b) Batching and Weighing Equipment	1103.02, 1103.03
(c) Vibrator	1103.17
(d) Membrane Curing Equipment	1101.09(b)

CONSTRUCTION REQUIREMENTS

422.04 Cooperation. The Contractor shall cooperate with the Railroad in order to eliminate undue delays to railroad traffic.

422.05 Composition of Concrete. The requirements of Article 1020.14 shall govern the mixing and placing of the concrete during cold weather.

422.06 Subgrade Preparation. After the Railroad has removed or blocked up the existing rails and ties, and has removed and replaced the ballast, the Contractor shall tamp or roll the subgrade until compacted to a uniform density throughout, true to grade and cross section.

422.07 Forms and Form Setting. Side forms shall be of lumber of not less than 50 mm (2 in.) nominal thickness, or of steel of equal rigidity. They shall be held securely in place by stakes or braces with the top edges true to line and grade.

422.08 Placing and Finishing. The subgrade shall be moistened just before the concrete is placed. While the tracks are blocked up or removed, the concrete for the lower slab shall be placed in successive batches for the entire width of the slab, tamped until all voids are removed, consolidated with a vibrator along the edges, and struck off to true line and even surface with floats and trowels. The final troweling shall be done with a steel trowel leaving a smooth, even surface. After the crossties have been reset and aligned and before the Railroad is allowed to relay the track in its final position, the Contractor shall apply one coat of Liquid Asphalt, (RC-70), to the top of the base slab. The concrete in the upper portion or top slab shall then be placed in successive batches for the entire width of the slab, tamped until all voids are removed, consolidated with a vibrator along the edges and ties, struck off to a true line and even surface, edged according to Article 420.11(d) and broomed according to Article 503.17(d).

422.09 Adjustments. In order to secure an even track surface, it may be necessary to correct for variations in thickness of the crossties by one of the following methods:

- (a) Place the base slab approximately 15 mm (1/2 in.) lower than shown on the plans and provide a cement grout between the top of the base slab and the bottom of the ties; or
- (b) The ties shall be placed as soon as practicable after the placing of the 200 mm (8 in.) base slab and the elevation adjusted as the ties are laid in the plastic concrete.

422.10 Bituminous Filler for Rails and Flangeways. The bituminous material used to fill in around the rails and form the flangeways shall be a cold-lay sand-bituminous mixture meeting the requirements of the Engineer.

The cold-lay bituminous material used as the filler around the rails shall be laid only when the contact surfaces are dry. No mixture shall be laid when the air temperature is below 5 °C (40 °F). Care shall be taken to prevent the bituminous mixture from becoming mixed with foreign materials. The contact surfaces of the rail and concrete shall be painted with a thin, uniform coating of Liquid Asphalt: RC-70 just before the bituminous cold-lay mixture is placed. The mixture shall be tamped thoroughly into place to the elevation shown on the plans or as directed by the Engineer.

422.11 Protective Coat. Linseed oil and petroleum spirits shall be applied according to Article 420.21.

422.12 Backfill. After the concrete has been cured, the spaces along the edges of the crossing shall be backfilled to the required elevation with approved granular material. The material shall be compacted and the surface neatly trimmed or graded.

422.13 Disposal of Surplus Material. Surplus or waste material resulting from the crossing construction operations shall be disposed of by the Contractor according to Article 202.03.

422.14 Method of Measurement. Portland Cement Concrete Railroad Crossing will be measured for payment in place and the area computed in square meters (square yards).

Reinforcement bars will be measured for payment in kilograms (pounds) as specified in Article 508.07.

422.15 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for PORTLAND CEMENT CONCRETE RAILROAD CROSSING.

Reinforcement will be paid for according to Section 508.

The protective coat will not be paid for separately but shall be considered as included in the unit price bid for Portland Cement Concrete Railroad Crossing.

SECTION 423. PORTLAND CEMENT CONCRETE DRIVEWAY PAVEMENT

423.01 Description. This work shall consist of a portland cement concrete driveway pavement constructed on a prepared subgrade, according to requirements of Section 420 insofar as they apply.

423.02 Method of Measurement. Portland cement concrete driveway pavement will be measured for payment in place and the area computed in square meters (square yards).

423.03 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for PORTLAND CEMENT CONCRETE DRIVEWAY PAVEMENT, of the thickness specified.

SECTION 424. PORTLAND CEMENT CONCRETE SIDEWALK

424.01 Description. This work shall consist of portland cement concrete sidewalk and sidewalk aprons constructed in one course on a prepared subgrade. This item shall apply to sidewalk and sidewalk aprons placed on earth or other subgrade, but shall not apply to sidewalk that is integrally a part of a structure.

424.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Portland Cement Concrete	1020
(b) Preformed Expansion Joint Filler	1051

424.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Concrete Mixers	1103.01
(b) Batching and Weighing Equipment	1103.02, 1103.03
(c) Membrane Curing Equipment	1101.09(b)

CONSTRUCTION REQUIREMENTS

424.04 Subgrade Preparation. The subgrade shall be tamped or rolled until thoroughly compacted and at the proper line and grade as shown on the plans. At locations where sidewalk is constructed at entrances, the sidewalk shall be thickened to the thickness of the adjacent entrance or driveway pavement.

424.05 Forms. Side forms shall be of lumber of not less than 50 mm (2 in.) thickness or of steel of equal rigidity. They shall be held securely in place by stakes or braces, with the top edges true to line and grade. Forms for the sidewalk aprons

shall be set so that the slab will have a uniform fall between the sidewalk proper and the curb grade.

At the Contractor's option, slipforming using equipment approved by the Engineer will be allowed.

424.06 Placing and Finishing. The subgrade shall be moistened just before the concrete is placed. The concrete shall be placed in successive batches for the entire width of the slab, struck-off, consolidated and finished to a true and even surface with floats and trowels. The final troweling shall be done with a wooden float, leaving an even surface. Steel trowels shall not be permitted. After the water sheen has disappeared, the surface shall be given a final finish by brushing with a whitewash brush. The brush shall be drawn across the sidewalk at right angles to the edges of the walk, with adjacent strokes slightly overlapping, producing a uniform, slightly roughened surface with parallel brush marks.

The surface shall be divided by grooves constructed at right angles to the centerline of the sidewalk. These grooves shall extend to 1/4 the depth of the sidewalk, shall be not less than 3 mm (1/8 in.) nor more than 6 mm (1/4 in.) in width, and shall be edged with an edging tool having a 6 mm (1/4 in.) radius. No slab shall be longer than 1.8 m (6 ft) nor less than 1.2 m (4 ft) on any one side, unless otherwise ordered by the Engineer. The edges of the slabs shall be edged as described above.

424.07 Expansion Joints. Expansion joints of the thickness specified below shall consist of preformed joint filler. The top of the joint shall be placed 6 mm (1/4 in.) below the surface of the sidewalk.

- (a) 15 mm (1/2 in.) Thick Expansion Joints. Expansion joints 15 mm (1/2 in.) thick shall be placed between the sidewalk and all structures such as light standards, traffic light standards, traffic poles and subway columns, which extend through the sidewalk.
- (b) 20 mm (3/4 in.) Thick Expansion Joints. Transverse expansion joints 20 mm (3/4 in.) thick shall be placed at intervals of not more than 30 m (100 ft) in the sidewalk. Where the sidewalk is constructed adjacent to pavement or curb having expansion joints, the expansion joints in the sidewalk shall be placed opposite the existing expansion joints as nearly as practicable. Expansion joints shall also be placed where the sidewalk abuts existing sidewalks, between driveway pavement and sidewalk, and between sidewalk and curbs where the sidewalk abuts a curb.

424.08 Sidewalk Ramps. Sidewalk accessibility ramps to the disabled shall be constructed of the type and at the locations shown on the plans in alignment with normal sidewalk and/or crosswalk and shall have sufficient curb length at the corner radius to prevent vehicular encroachment.

Sidewalk ramps at marked crossings shall be wholly contained within the markings, excluding any flared sides. The slope of the side flares shall be as shown on the plans.

Sidewalk ramps shall be constructed and cured as specified in this Section except that final texturing shall be accomplished with an expanded metal grate pressed into the plastic concrete and removed to form a diamond pattern as shown on the plans.

Sidewalk ramps shall be constructed to the same thickness as the adjacent sidewalk with a minimum thickness of 100 mm (4 in.) and shall be measured and paid for as specified for the item of sidewalk involved, and no additional compensation will be allowed.

424.09 Backfill. After the concrete has been cured, the spaces along the edges of the sidewalk and ramps shall be backfilled to the required elevation with approved material. The material shall then be compacted until firm, and the surface neatly graded.

424.10 Disposal of Surplus Material. Surplus or waste material resulting from the sidewalk construction operations shall be disposed of by the Contractor according to Article 202.03.

424.11 Method of Measurement. Portland cement concrete sidewalk and accessibility ramps will be measured for payment in place, and the area computed in square meters (square feet).

424.12 Basis of Payment. This work will be paid for at the contract unit price per square meter (square foot) for PORTLAND CEMENT CONCRETE SIDEWALK of the thickness specified, which price shall include all required expansion joints, special texturing, and variable height edge treatment at sidewalk ramps.

Earth excavation required will be paid for according to Section 202.

PAVEMENT REHABILITATION

SECTION 440. REMOVAL OF EXISTING PAVEMENT AND APPURTENANCES

440.01 Description. This work shall consist of the removal and satisfactory disposal of all existing pavement, base and stabilized subbase, including resurfaced pavement; curb, gutter, and combination curb and gutter, including gutter inlets, outlets, and entrances; paved ditch, median, paved shoulders, driveway pavement, and sidewalk; bituminous surfaces in preparation for subsequent resurfacing; and the partial depth removal of concrete medians. The reference to "paved shoulders" in this Section shall include those shoulders constructed of bituminous and portland cement concrete.

CONSTRUCTION REQUIREMENTS

440.02 General. All existing pavement, including surface courses, base courses, and stabilized subbases, and other appurtenances as listed above, which

interfere with construction work shall be completely removed as shown on the plans or as directed by the Engineer. When portions of existing pavement and appurtenance are to remain in place, provisions shall be made for satisfactory transitions between replacements and the portions remaining in place. The Contractor shall form a perpendicular straight joint by full-depth machine sawing at the ends and all edges of portions to be removed to prevent surface spalling when the concrete is broken out. Any damage done to the existing pavement or appurtenance to remain in place shall be repaired or removed and replaced by the Contractor at his/her own expense, as directed by the Engineer.

It shall be the responsibility of the Contractor to determine the thickness of the existing pavement structure, including overlays, and other appurtenances to be removed, and the extent to which they are reinforced. No additional compensation will be allowed because of variations from the assumed thickness(s) or from the thickness(s) shown on the plans, or for variations in the amount of reinforcement.

Gutter removal shall include the complete removal of all inlets, outlets and entrances that are contained within the limits of the designated removal. The removal of outlets shall include the entire discharge trough and end curtain wall for trough type outlets and the concrete box and outlet pipe for drop box type outlets.

Paved ditch removal shall include the complete removal of all anchor walls and cut-off walls that are contained within the limits of the designated removal.

Any excavation made by the Contractor for the removal shall be replaced. The excavated space shall be filled with material satisfactory to the Engineer and placed according to Section 205 by and at the expense of the Contractor.

440.03 Bituminous Surface Removal for Subsequent Resurfacing. The machine for the removal of bituminous surfaces in preparation for subsequent resurfacing shall be a self-propelled planing machine or a self-propelled milling machine.

The planing machine shall have a wheel base width of not less than 3 m (10 ft) and shall be capable of heating, planing and cutting the old surface and depositing the cuttings into a windrow in one or more passes.

The milling machine shall be capable of cold milling and cutting the existing surface and depositing the cuttings into a windrow or directly loading the cuttings into a truck. It shall be capable of removing a layer of bituminous material at least 1.8 m (6 ft) in width and 40 mm (1 1/2 in.) in depth in a single pass. When the width of surface removal is less than 1.8 m (6 ft), machines less than 1.8 m (6 ft) wide will be permitted except that the area milled shall not be wider than the width of the work specified on the plans. The milling machine shall be capable of accurately and automatically establishing profile grades by reference from either the existing pavement or from an independent grade control to provide a milled surface within a tolerance of 5 mm (3/16 in.) in 5 m (16 ft) when tested with a 5 m (16 ft) straightedge. It also shall have an effective means for removing all loose and excess material from the surface and for preventing any dust resulting from the operation from escaping into the air.

The existing bituminous surface shall be removed to the depth specified on the plans. The temperature at which the work is performed, the nature and condition of the equipment, and the manner of performing the work shall be such that the planed or milled surface is not torn, gouged, shoved or otherwise damaged by the planing or milling operation. Sufficient cutting passes shall be made so that all irregularities or high spots are eliminated to the satisfaction of the Engineer. When tested with a 5 m (16 ft) straightedge, the planed or milled surface shall have no surface variations in excess of 5 mm (3/16 in.).

Removing the existing bituminous surface to the required depth adjacent to structures in the pavement surface such as drain castings and utility covers shall be accomplished in a manner satisfactory to the Engineer using either machine or hand methods.

440.04 Median Removal Partial Depth. The equipment used for median removal partial depth shall be a self-propelled mobile unit capable of removing the concrete to the depth specified by a cold milling process utilizing tungsten carbide cutting tools. The equipment shall be capable of accurately controlling the elevation and cross slope of the removal, and shall have an effective means of removing the material from the median and of preventing dust from escaping into the air.

440.05 Removal and Replacement. Except as provided for in Section 441 or when otherwise specified, whenever the plans indicate that the existing pavement structure and/or appurtenances are to be removed and replaced, the removal and the replacement shall be performed and paid for as separate items. Removal shall be according to the requirements specified herein. Replacement shall be according to Sections of these Specifications that pertain to the specific item or items being replaced.

440.06 Disposal of Material. Materials resulting from the removal of existing pavement and appurtenances as herein specified shall be disposed of as specified in Article 202.03.

440.07 Method of Measurement.

- (a) **Contract Quantities.** The requirement for use of contract quantities shall be according to Article 202.07(a).
- (b) **Measured Quantities.** Pavement removal and driveway pavement removal shall be measured for payment in place and the area computed in square meters (square yards).

Bituminous surface removal for subsequent resurfacing will be measured for payment in place and the area computed in square meters (square yards) for each specified increment thickness of material removed.

Curb removal, gutter removal, combination curb and gutter removal and paved ditch removal will be measured for payment in meters (feet). The measurement for curb removal and combination curb and gutter removal will be made along the face of the curb. Paved ditch removal will be measured along the flow line of the paved ditch. Gutter removal will be measured

along the edge of the gutter which is in actual contact with the edge of the pavement.

Sidewalk removal, median removal and median removal partial depth will be measured for payment in place and the area computed in square meters (square feet).

Removal of any of the items listed above outside the designated limits as shown on the plans or as directed by the Engineer will not be measured for payment. The removal of base and stabilized subbase will not be measured for payment as separate items, but shall be considered as included in the contract unit price for Pavement Removal, and no additional compensation will be allowed.

440.08 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for PAVEMENT REMOVAL, DRIVEWAY PAVEMENT REMOVAL and PAVED SHOULDER REMOVAL; at the contract unit price per square meter (square yard) for BITUMINOUS SURFACE REMOVAL of the thickness specified; at the contract unit price per meter (foot) for CURB REMOVAL, GUTTER REMOVAL, COMBINATION CURB AND GUTTER REMOVAL, and PAVED DITCH REMOVAL; and at the contract unit price per square meter (square foot) for SIDEWALK REMOVAL, MEDIAN REMOVAL and MEDIAN REMOVAL PARTIAL DEPTH. The contract unit price for Pavement Removal shall include removing and disposing of the entire pavement structure.

The contract unit price for Gutter Removal shall include removing all inlets, outlets and entrances, including concrete boxes and outlet pipes, and discharge troughs and end curtain walls even though they may partially extend beyond the limits of measurement.

The contract unit price for Pavement Removal shall include removing and disposing of the entire pavement structure, including surface, base, and any stabilized subbase.

The contract unit price for Paved Ditch Removal shall include removing any and all anchor walls and cut-off walls encountered.

SECTION 441. PAVEMENT REPLACEMENT

441.01 Description. This work shall consist of the removal and replacement, and any necessary excavation and embankment of all surface, base course, and subbase as shown on the plans.

Where all of the pavement, including subbase, base and surface course, is to be replaced, the item will be specified as "Pavement Replacement". If only surface course, binder course, cushion and joint filler is to be replaced, the item will be specified as "Pavement Replacement - Surface Course".

The term "excavation" or "embankment" as used in this Article refers only to that necessary for the preparation of the subgrade, where the "Pavement Replacement" is full depth.

441.02 Materials. Materials shall meet the requirements of Section 1000 - Materials.

CONSTRUCTION REQUIREMENTS

441.03 General. All base, surface courses or subbase removed shall be restored to the original cross section.

The elevation of the surface of the replaced surface course shall not vary more than 3 mm (1/8 in.) from the elevation of the surface of the adjoining surface course. The subgrade in the case of surface, base course and subbase removal, and the cushion or filler on the base course in the case of surface course removal, shall be adjusted so that this result will be obtained.

Pavement damaged by reason of construction operations outside of the working limit of 600 mm (2 ft) from the form line specified shall be replaced by the Contractor at his/her own expense.

441.04 Portland Cement Concrete Base and Surface Courses. Portland cement concrete base or surface courses or natural cement concrete base or surface courses which are removed shall be replaced with portland cement concrete base or surface courses meeting the requirements of Sections 353 and 420, respectively, except that hand methods of consolidating and finishing will be permitted.

441.05 Brick, Granite Block and Wood Block Surface Courses. Brick, granite block or wood block surface courses which are removed shall be replaced if specified on the plans or directed by the Engineer. Whole sound brick, granite blocks or wood blocks taken from the original surface course shall be used in the replacement. If additional brick, granite blocks or wood blocks are required, the Contractor shall furnish a similar type and size to those which are being replaced. Brick, granite block or wood block surface course shall be laid on a sand or limestone screenings cushion approximately 25 mm (1 in.) thick, and shall have the joints filled with asphalt. The surface or base, may be restored to the proper elevation by use of an approved compacted bituminous material or air-entrained portland cement concrete according to Article 441.04.

441.06 Bituminous Surface and Binder Courses. Bituminous surface and binder courses which are removed shall be replaced by an equal thickness of bituminous materials meeting the requirements of either Section 405 or 406. The type used shall be that which closely conforms to the type which was removed, and shall be approved in writing by the Engineer.

441.07 Gravel or Crushed Stone Base and Surface Courses. Gravel or crushed stone base and surface courses which are removed shall be replaced by an equal thickness of materials meeting the requirements of Section 351 or Section 402. The type used shall be that which closely conforms to the type which was removed and shall be approved in writing by the Engineer.

441.08 Base and Subbase Replacement. All granular or stabilized base and subbase which are removed shall be replaced with an equal compacted thickness of

material which closely conforms to the original material removed and shall be compacted to the density requirements of the granular or stabilized base and subbase removed.

441.09 Disposal of Surplus Material. Surplus or waste material resulting from the removal and replacement operations shall be disposed of by and at the expense of the Contractor according to Article 202.03.

441.10 Method of Measurement. Pavement Replacement and Pavement Replacement - Surface Course, will be measured in place, and the area computed in square meters (square yards). Pavement or surface course damaged by reason of construction operations outside of the working limit of 600 mm (2 ft) from the form line specified will not be measured for payment.

441.11 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for PAVEMENT REPLACEMENT or PAVEMENT REPLACEMENT - SURFACE COURSE, which prices shall include any required earth excavation or embankment.

SECTION 442. PAVEMENT PATCHING

442.01 Description. This work shall consist of the removal of the existing pavement, the necessary excavation and the replacement with the class and type of patch specified at designated locations.

This work will be classified as follows:

Class A Patches:	Pavement Removal and Continuously Reinforced Portland Cement Concrete Replacement
Class B Patches:	Pavement Removal and Portland Cement Concrete Replacement Using Dowels or Tie Bars
Class C Patches:	Pavement Removal and Portland Cement Concrete Replacement
Class D Patches:	Pavement Removal and Bituminous Concrete Replacement
Pavement Patching:	Contractor's Option of Class C or Class D

For each of the above classifications, the work on a lane width or less shall be further quantified by size as follows:

Type I	Less than 5sq m (5 sq yd)
Type II	5 sq m (5 sq yd) or more, but less than 15sq m (15 sq yd)
Type III	15 sq m (15 sq yd) or more, but less than 20sq m (25 sq yd)
Type IV	20 sq m (25 sq yd) or more

442.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Portland Cement Concrete (Note 1)	1020
(b) Concrete Reinforcement Bars, Fabric and Strand	1006.10
(c) Dowel Bars, Expansion Joint Assembly and Contraction Joint Assembly (Note 2)	1006.11
(d) Preformed Expansion Joint Filler	1051.08, 1051.09
(e) Preformed Fiberboard	1051.04
(f) Bituminous Materials	1009.01 - 1009.05, 1009.07, 1009.08
(g) Non-shrink Grout	1024.01
(h) Poured Joint Sealer	1050.02
(i) Backer Rod (Note 3)	
(j) Material for Forming Joint Grooves (Note 4)	
(k) Chemical Adhesive	1027.01

Note 1. When patching ramp pavements and two-lane pavements with two-way traffic, the special patching mixture specified in Article 1020.05(g)(2) shall be used for Class A, Class B and Class C patching. For all other pavements, either the early strength patching mixture specified in Article 1020.05(g)(1) or the special patching mixture shall be used, at the Contractor's option, for Class A, Class B and Class C patching.

Note 2. For Class B patches, the dowel bars shall be painted round bars conforming to the requirements of AASHTO M 227M (M 227), grades 70 through 80. The dowel bars may be painted with red oxide or zinc chromate one-coat shop paint.

Note 3. The backer rod shall be a closed-cell, plastic foam rod compatible with the sealant and the elevated temperatures of joint sealant application.

Note 4. Material for joint forms shall be suitable for forming the sealant reservoir to the width and depth as shown on the plans and of sufficient strength to retain its shape during concrete placement.

442.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Self-Propelled Rollers	1101.01
(b) Vibratory Rollers (Note 1)	
(c) Side Forms (Note 2)	1103.05
(d) Mixer or Truck Agitator (Note 3)	1103.01
(e) Batching and Weighing Equipment (Note 4)	1103.02, 1103.03
(f) Hot-Mix Plant	1102.01
(g) Concrete Saw (Note 5)	
(h) Wheel Saw (Note 6)	
(i) Equipment and Devices for Removing Old Concrete Slabs (Note 7)	
(j) Drilling Machine (Note 8)	
(k) Miscellaneous Equipment	1103.17
(l) Membrane Curing Equipment	1101.09

- (m) Heating Equipment for Joint Sealant (Note 9)
- (n) Skid Steer Loader Equipped with a Hydraulic Hammer 1101.14

Note 1. The vibratory rollers and tampers shall meet the approval of the Engineer.

Note 2. Wood forms will be permitted. The depth of form shall be plank width, the commercial dimension which equals the pavement thickness shown on the plans or the next larger commercial dimension.

Note 3. Batch type mixer having a rated capacity of not less than 0.3 cu m (10 cu ft) may be used. Chute delivery will be permitted.

Note 4. Where the nominal production does not exceed 40 cu m (50 cu yd) per day, the requirement for overhead bins and weighing hoppers completely suspended and hanging freely from the scales may be waived. Any other method for loading and weighing the aggregates must be approved by the Engineer.

Note 5. The concrete saw shall be equipped with a diamond blade of sufficient size to saw pavements full-depth and be capable of accurately maintaining cutting depth.

Note 6. The wheel saw shall be equipped with carbide-tipped rotating cutters and be capable of accurately maintaining cutting depth.

Note 7. As approved by the Engineer.

Note 8. The machine used for drilling the holes in the face of the existing pavement shall be capable of drilling the size and depth of holes as shown on the plans. The machine shall be equipped with a positive stop to control the depth of hole. During use, the stop shall be calibrated at least once a day. A drill support system using the pavement surface as a reference shall be required to assure hole alignment at mid-depth of portland cement concrete pavement. Hand held tools will not be allowed.

Note 9. The heating equipment shall be an indirect heating type with positive temperature control, mechanical agitation and recirculating pumps.

CONSTRUCTION REQUIREMENTS

442.04 Keeping Road Open to Traffic. The road shall be kept open to traffic according to Article 701.05(e).

442.05 Pavement Removal. The pavement shall not be scored with a concrete saw or jackhammers more than three days prior to when it will be broken except when the pavement is closed to traffic. The pavement shall not be scored with a wheel saw more than one day prior to when it will be broken except when the pavement is closed to traffic.

If a wheel saw is used to score the pavement or areas of the pavement have been removed for purposes of cutting marginal bars and the pavement will be open to traffic, the cuts shall be filled with either full-depth cold bituminous mix meeting the approval of the Engineer or compacted granular material with a 50 mm (2 in.) minimum cap of cold bituminous mix meeting the approval of the Engineer. The cuts shall be constantly maintained so that they will not be a hazard to traffic.

Any drainage mat or pipe underdrains damaged during patching operations shall be repaired or replaced by the Contractor at his/her own expense.

Materials resulting from the removal of the existing pavement and unsuitable and unstable materials shall be disposed of according to Article 202.03.

The scoring and removal of pavement for the various classes of patches shall be as follows:

- (a) Class A Patches. Two transverse saw cuts shall be made perpendicular to the centerline at each end of the patch except that the saw cuts may be skewed slightly if necessary to maintain a minimum distance of 450 mm (18 in.) from the end of the patch to the nearest transverse crack in the pavement to remain in place. When approved by the Engineer, this minimum distance may be reduced to 150 mm (6 in.) in areas of close crack spacing where the pavement otherwise appears to be sound. The interior saw cut shall be made at the location that will provide the proper length of exposed existing steel as shown on the plans and shall be either full-depth or to a depth which will completely sever the longitudinal reinforcement. The longitudinal edges of the patch shall be formed by full-depth saw cuts. Patches one-half lane width or full lane width will be permitted. Saw cut extensions into pavement which is to remain in place will not be permitted. All outlining and interior saw cuts shall be made with an approved concrete saw. After the interior saw cuts have been made, an approved wheel saw may be used to make pressure relief cuts or intermediate cuts to reduce the pavement length to a size that accommodates removal and hauling operations, at the Contractor's expense. The wheel saw cutting operations shall be controlled to limit subbase penetration to a maximum of 15 mm (1/2 in.).

The shoulder between the full-depth saw cut and the pavement edge shall be removed using a hand held hammer and hand tools prior to pavement removal. If available, the Contractor may use an approved wheel saw to make the shoulder cut and removal.

When the patch is adjacent to a portland cement concrete shoulder, a saw cut shall be made at the shoulder-pavement joint sufficiently deep to sever the tie bars. A second full-depth saw cut shall be made in the pavement a minimum of 100 mm (4 in.) from the edge of the shoulder. The pavement between the full-depth saw cut and the shoulder edge shall be removed using a hand held hammer and hand tools prior to removal of the remaining pavement.

The pavement between the interior saw cuts shall be removed by lifting. Sufficient care shall be taken to minimize subbase disturbance and prevent

spalling of the pavement that is to remain in place. Any subbase or stabilized subbase material disturbed during pavement removal operations or determined unsuitable by the Engineer shall be removed and replaced with patch material.

If the Engineer determines that the concrete has deteriorated to the extent that it is not practical to lift, the pavement may be broken into small pieces and removed. The breaking equipment shall not transfer an impact energy greater than 4000 J (3000 ft lb) per blow to the pavement surface.

The concrete in the splicing area, between the interior and outer saw cuts, shall be removed using hand held hammers and hand tools. The Contractor has the option to use a skid steer loader equipped with a hydraulic hammer to remove the concrete in the splicing area. Should the loader and hydraulic hammer damage the pavement and/or reinforcement which are to remain in place, the loader with a hydraulic hammer will no longer be allowed.

To prevent underbreaking concrete to remain in place, the face of the concrete below the partial-depth saw cut shall be inclined slightly into the patch. The reinforcing steel in the splicing area shall not be bent to aid in removal of the concrete. If more than ten percent of the reinforcing steel in the splice area is damaged due to the Contractor's operations, the patch shall be lengthened at his/her own expense to provide the required steel exposure for splicing. If less than ten percent of the existing lap steel is damaged, it may be repaired by welding in lieu of lengthening the patch. No welding will be permitted on the splices between the existing steel and the new steel.

Should the Contractor's operations cause a spall having a width or depth greater than 25 mm (1 in.) in the pavement to remain in place or cause excessive shattering or underbreaking of the existing slab to remain in place, a new saw cut shall be made, at the Contractor's expense, extending the patch to remove the spall or underbreaking. After pavement removal, the pavement structure will be inspected by the Engineer to determine if it is sufficiently sound. If determined unsound, the Contractor shall extend the patch as directed by the Engineer.

The existing reinforcement steel shall be observed during the removal process to determine if there is any excess rusting or evidence of steel distress. Deteriorated steel will not be permitted in the splice area. The Engineer may require lengthening of the patch.

- (b) Class B Patches. Two transverse saw cuts outlining the patch shall be straight and perpendicular to the centerline, with a tolerance of 50 mm (2 in.) in 3.6 m (12 ft). The wedge of pavement formed by the interior (third) saw cut shall be removed with a hand held hammer and hand tools prior to pavement liftout. Saw cut extensions into pavement which are to remain in place will not be permitted. All saw cuts shall be made with an approved concrete saw (except as outlined below). Concrete not sawed full-depth shall be removed with hand tools. Only full lane width patches will be permitted.

When the patch is adjacent to a bituminous shoulder, a full-depth saw cut shall be made in the shoulder a minimum of 100 mm (4 in.) from the edge of the pavement or at such width as to facilitate forming. The shoulder between the full-depth saw cut and the pavement edge shall be removed with a hand held hammer and hand tools prior to pavement liftout.

When the patch is adjacent to a portland cement concrete shoulder, a saw cut shall be made at the shoulder-pavement joint sufficiently deep to sever the tie bars. A second full-depth saw cut shall be made in the pavement a minimum of 100 mm (4 in.) from the edge of the shoulder. The pavement between the full-depth saw cut and the shoulder edge shall be removed using a hand held hammer and hand tools prior to removal of the remaining pavement.

The Contractor may use an approved wheel saw to make the shoulder cut and removal, and to make pressure relief cuts or intermediate cuts to reduce the pavement length to a size that accommodates removal and hauling operations, at the Contractor's expense. The wheel saw cutting operations shall be controlled to limit subbase penetration to a maximum of 13 mm (1/2 in.). Wheel saw cuts shall be made after concrete sawing outlining patch boundaries unless the wheel saw cuts are at least 450 mm (18 in.) inside the transverse patch boundaries. Should the Contractor be unable to conform to the requirements specified herein, the Engineer will withdraw approval of this alternative.

The pavement shall be removed by lifting. If the Engineer determines that the concrete has deteriorated to the extent that it is not practical to lift, the pavement may be broken into small pieces and removed. Breaking operations shall start adjacent to the removed wedge or the alternate wheel saw cut. The breaking equipment shall not transfer an impact energy greater than 4000 J (3000 ft lb) per blow to the pavement surface.

Care shall be taken to prevent subbase disturbance and spalling of the pavement which is to remain in place. Should the Contractor's operations cause a spall having a width or depth greater than 25 mm (1 in.), a new saw cut shall be made extending the patch to remove the spall, at the Contractor's expense. After slab removal, the existing pavement structure will be inspected by the Engineer to determine if it is sufficiently sound. If determined unsound, the Contractor shall extend the patch as directed by the Engineer. Any subbase or stabilized subbase material that is disturbed during pavement removal operations or determined unsuitable by the Engineer shall be removed and replaced with patch material.

Resawing of patch boundaries to remove spalls that exceed a width or depth of 25 mm (1 in.) will not be required when the patching is being performed to prepare the existing pavement for bituminous resurfacing.

- (c) Class C Patches. Standard reinforced concrete pavement shall be scored with a concrete saw to a depth which severs the reinforcement. If the Contractor elects, he/she may saw full depth to alleviate spalling and replacement as specified in Article 442.05(a).

Non-reinforced concrete pavement shall be scored with jackhammers or other equipment approved by the Engineer. The scoring shall be at least 150 mm (6 in.) from the marked face of the patch. Marginal bars and tie bars shall be cut in a manner satisfactory to the Engineer.

As an alternate, the Contractor may use an approved wheel saw to score the pavement full-depth on either standard reinforced or non-reinforced pavement. Should the wheel saw damage the pavement and/or reinforcement which are to remain in place, the Engineer will withdraw approval of this alternate.

The existing pavement shall be removed as shown on the plans. Ends of the patch need not be squared but may follow the existing cracks, provided angles smaller than those shown on the plans do not result.

If the patch is not scored with a concrete saw or wheel saw, the ends of the patch shall be hand trimmed with hand held hammers or other tools or equipment approved by the Engineer. The general plane of the cut face shall not deviate more than 40 mm (1 1/2 in.) from vertical. Abrupt breaks or deviations from the plane of the cut face sufficient to induce spalling in either the top or the bottom surface of the pavement will not be permitted.

Should the Contractor's operations cause a spall having a width or depth greater than 25 mm (1 in.), the patch shall be extended to remove the spall, at the Contractor's expense, except that this extension will not be required when the patching is being performed to prepare the existing pavement for bituminous resurfacing.

Equipment and methods used for removing old pavement shall be such as to prevent cracking, shattering or spalling of the pavement remaining in place. Breaking equipment shall not transfer an impact energy greater than 4000 J (3000 ft lb) per blow to the pavement surface.

After breaking and removal of the existing pavement, any areas of the subbase which are below the required elevation of the finished subbase, shall be built up to grade at the Contractor's expense, with satisfactory compacted granular material, concrete or compacted bituminous material.

Tie bars extending across the longitudinal joint, or such portion as may be exposed in the area of the patch, shall be cut approximately at the face of the pavement which is to remain in place, or they shall be removed. Marginal bars shall be cut close to the face of the pavement which is to remain in place.

- (d) Class D patching shall be according to Article 442.09.

442.06 Pavement Replacement. Class A, Class B and Class C patches shall conform to the standard details and cross section included in the plans, and the work shall conform to the applicable portions of Section 420, with the following exceptions:

- (a) Placing Reinforcement and Dowel Bars.

- (1) General. The reinforcement shall be as shown on the plans. Patches 6 m (20 ft) or longer shall be tied to the adjacent lane of existing pavement, portland cement concrete shoulders, and curb and gutter with No. 20 (No. 6) transverse tie bars, 600 mm (24 in.) long, embedded 200 mm (8 in.) at 600 mm (24 in.) centers according to Article 420.10(b).
- (2) Class A Patching. Half-lane patches 6 m (20 ft) or longer shall be tied to the adjacent existing pavement, portland cement concrete shoulders, and curb and gutter with No. 20 (No. 6) transverse tie bars, 600 mm (24 in.) long, embedded 200 mm (8 in.) at 600 mm (24 in.) centers according to Article 420.10(b). The Contractor shall tie the steel together, using at least two secure ties for each lap splice. The details shall be as shown on the plans.

Should an existing lap splice be encountered in the patch slice area, the Contractor shall construct the new splice by tying both of the exposed reinforcement bars to the new reinforcement bar.

Reinforcement steel shall be placed and supported on chairs according to Article 421.06 such that uniform unsupported lengths not exceeding 1.2 m (4 ft) are provided. In such cases where an uneven subbase hinders maintenance of a placement tolerance of ± 25 mm (1 in.) vertically, portland cement concrete, sand-cement grout, or bituminous hot mixture shall be used to adjust the chair height to allow the reinforcement to be placed within the specified tolerances.

When the existing reinforcement is fabric, the longitudinal reinforcement bars shall be the same size and spacing as the existing longitudinal reinforcement.

- (3) Class B Patching. Dowel and tie bar holes shall be drilled as shown on the plans, and parallel to the grade and centerline of the pavement with a tolerance of 3 mm (1/8 in.) in 300 mm (12 in.). The drilling operation shall not crack or spall the pavement.

Immediately prior to grouting the dowel bars or tie bars, the holes shall be thoroughly cleaned of drilling debris. Dust and debris shall be blown from the joint or crack with a power brush/blower or with compressed air. If compressed air is used, the pneumatic tool lubricator must be bypassed and a filter installed on the discharge valve to keep water and oil out of the lines. The dowel bars shall be clean and free from rust.

An approved chemical adhesive shall be used as the anchoring material for dowel bars. At the Contractor's option, either an approved non-shrink grout or chemical adhesive shall be used as the anchoring material for tie bars.

The grout or chemical adhesive shall be of a consistency such that the dowel or tie bar may be easily inserted into the hole with flow completely surrounding the bar, and without appreciable runout of grout or chemical adhesive after the bar is fully inserted. (The consistency of

the grout should be thicker than the consistency recommended by the manufacturer's directions). The grout or chemical adhesive shall be injected to the back of the hole to eliminate air pockets prior to inserting the bar. The quantity of material used shall be such that the grout or chemical adhesive is dispersed along the entire length of the bar and voids are completely filled. After the material has been positioned at the back of the hole, the bar shall be fully inserted, using a back-and-forth twisting motion, leaving the proper length exposed as shown on the plans. If it is necessary to use a hammer to aid in seating a dowel, the exposed end of the dowel shall be protected with a wood block.

Immediately prior to placing the concrete, the exposed ends of dowel bars shall be cleaned and lightly oiled.

Class B patches Type III or Type IV shall be reinforced with pavement fabric according to the details shown on the plans. The reinforcement shall be placed at 90 mm \pm 25 mm (3 1/2 in. \pm 1 in.) below the final finished patch surface elevation according to Article 420.09, except that placement of reinforcement by mechanical or vibratory means will not be permitted.

Hinge jointed pavement shall be patched according to the details shown on the plans and as specified for Class B patches. Patches 14 m (45 ft) or more in length shall have sawed contraction joints constructed according to the applicable requirements of Article 420.10 at 4.5 m (15 ft) maximum intervals and shall be in prolongation with joints or cracks in the adjacent lane whenever possible. Patches 4.5 m (15 ft) or longer shall be tied to the adjacent lane of existing pavement, portland cement concrete shoulders, and curb and gutter with No. 20 (No. 6) transverse tie bars, 600 mm (24 in.) long, embedded 200 mm (8 in.) at 600 mm (24 in.) centers according to Article 420.10(b).

- (4) Class C Patching. When the patched pavement is not to be resurfaced, transverse contraction joints shall be formed on 4.5 m (15 ft) to 6 m (20 ft) centers by sawing in all Class C patches that are 6 m (20 ft) or more in length. They shall be placed in prolongation with joints or cracks in the existing slab whenever possible.
- (b) Replacing Full Width Pavement. Unless through traffic is detoured, full width pavement shall be replaced in two or more operations. When replacing adjacent lanes in one operation, the longitudinal joint down the lane line shall be a sawed longitudinal joint as specified in Article 420.10, except that tie bars shall be included only for Type A, Type B, and Type C patches that are 6 m (20 ft) or more in length. When full-width pavement is replaced in two or more operations, a form shall be installed along the laneline by one of the following methods:
 - (1) Method 1. Whenever practicable, an approved form, not less than 6 mm (1/4 in.) in thickness, shall be set along the longitudinal joint when placing the patching in the first half width. The depth of this form shall be equal to the thickness of the new pavement being placed, or as close thereto as standard lumber measurements will allow. No

pavement in the lane open to traffic shall be removed to permit setting the form, and the form shall remain in place until the existing pavement in the opposite half width is removed.

- (2) Method 2. When the existing pavement in the opposite half width is so broken or disintegrated that it is not feasible to use Method 1, a wood form shall be set along the longitudinal joint when placing the patch in the first half width, except that a metal form may be used for Type III patches when mechanical finishing is employed. Only sufficient concrete shall be removed from the lane open to traffic to permit setting the form. As soon as permissible after the concrete is poured, the form shall be removed, and the trench occupied by the form shall be filled immediately with compacted granular material, which shall be constantly maintained in such a manner that it will not be a hazard to traffic.
- (c) Forms.
- (1) Side forms will be required.
 - (2) For Class B Patches, a bond breaker of 6 mm (1/4 in.) fiber board, or other material approved by the Engineer, shall be placed flush with the surface at the pavement centerline for the full length and depth of the patch. If the centerline sealant reservoir is to be formed, that part of the bondbreaker may be replaced by the joint reservoir form.
- (d) Concrete Delivery. Non-agitating trucks will not be permitted for transporting the mixed concrete, except in specific cases, and then only upon written permission of the Engineer.
- (e) Concrete Placement. For Class A, Class B and Class C Patches, concrete shall be placed according to Article 420.07 and governed by the limitations set forth in Article 1020.14, except that the maximum temperature of the mixed concrete immediately before placing shall be 35 °C (96 °F), the required use of an approved retarding admixture when the plastic concrete reaches 30 °C (85 °F) shall not apply, and placing of the special patching mixture, when its use is required, shall be only when the air and ground temperatures in the shade are at or above 13 °C (55 °F) and the temperature for the next eight hours is expected to remain above 5 °C (40 °F).

In the case of Class A Patches, if the subbase and subgrade material have been disturbed and/or removed in excess of plan pavement thickness plus subbase thickness or more from the surface of the pavement, the concrete shall be placed in lifts and separated by a bond breaker. The elevation of the bottom lift shall be level with the top of the subbase. A thin coating of rapid setting asphalt emulsion or thick coating of Type III curing compound shall be applied to the surface of the bottom lift. Care shall be taken to avoid coating the vertical faces of the existing pavement or any reinforcement. The remainder of the concrete shall be placed after the asphalt emulsion or curing compound has sufficiently cured but not before at least one day after placement of the bottom lift.

- (f) Consolidating and Finishing. The concrete shall be consolidated by internal vibration. Special attention shall be given to consolidating the concrete around the corners, edges, dowel bars, tie bars and reinforcement.

For Class A and Class B, the surface of the patch shall be struck off with two passes of a vibratory or rolling screed as approved by the Engineer. For Class C Patches, finishing may be performed by either machine or hand methods. For repairs 4 m (12 ft) or less in length, the screed shall be placed parallel to the edge of pavement. For repairs over 4 m (12 ft) in length, the screed shall be placed perpendicular to the edge of pavement. In striking off, the template shall be moved forward with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and manipulated so that neither edge is raised during the striking off process. A slight excess of concrete shall be kept in front of the cutting edge at all times during the striking off operation.

After strike off, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness by means of a 3 m (10 ft) straightedge according to Article 420.11(c).

Testing for hardened concrete shall be with a 3 m (10 ft) straightedge centered on the leading transverse patch boundary and continue until centered over the trailing patch boundary. 5 mm (3/16 in.) shall be the allowable tolerance used during testing.

Surface variations which exceed the above tolerances shall be marked by the engineer and removed by the contractor with an approved grinding device consisting of multiple saws. The use of the bush hammer or other impact devices will not be permitted.

For Class A and Class B patches which will not be overlaid, the surface shall be stamped with the current year approximately 300 mm (1 ft) from the outer edge of the lane.

- (g) Brooming and Edging. When patching pavements which have not been overlaid, the final finish shall match the surrounding pavement. When patching pavements which have been overlaid, the surface of the concrete shall be textured with a broom finish applied transversely to the pavement centerline. The texturing operation shall be executed so that the surface is uniform in appearance and free from rough and porous spots, irregularities and depressions. If directed by the Engineer, concrete adjacent to a longitudinal joint shall be edged.
- (h) Curing and Protection. In addition to Article 1020.13, when the use of the special patching mixture is required and the ambient temperature is between 13 °C - 30 °C (55 °F- 80 °F), it may be necessary to cover the patch with polyethylene and insulation (R12 minimum) and maintain cover and insulation until opening strength is reached. Insulation shall not be placed when the ambient temperature at placement is greater than 32 °C (90 °F).

When patching two or more lane widths of continuously reinforced concrete pavement in one operation and extreme daily temperature cycles are anticipated, the Engineer may require that 60 m (200 ft) of pavement on each end of the patch be covered with wet straw and burlap or an approved insulation blanket, and that the patch be cured with wet burlap and covered in a similar manner. When covering is required, it shall be in place during the curing period. If wet straw and burlap is used, it shall be maintained in a wet condition throughout the curing period. When covering is required by the Engineer, it shall be paid for according to Article 109.04.

- (i) Shoulder Replacement. After the forms are removed but prior to opening to traffic, the disturbed shoulder area shall be replaced with like material, compacted and restored to the existing line and grade.
- (j) Joint Sealing.
 - (1) In Class A patches, all centerline joints, longitudinal joints adjacent to portland cement concrete shoulders shall be sealed according to Article 420.14(a).
 - (2) In Class B patches, all transverse joints, centerline joints, longitudinal joints adjacent to portland cement concrete shoulders, and saw-cut extensions in the shoulders shall be sealed according to Article 420.14(a) and manufacturer's recommendations. The sealant reservoir at patch boundaries shall be formed in the fresh concrete or sawed to the dimensions shown on the plans. If the reservoir is to be sawed, sawing shall not be performed until after the required curing period. The faces of the reservoir shall be thoroughly cleaned by sandblasting and then blown clean with compressed air having a pressure of at least 620 kPa (90 psi) and a volume of 4 cu m/min (150 cfm) of air at the nozzle. The backer rod shall be uniformly placed at the depth shown on the plans or as directed by the Engineer.

The sealing shall be done in one pour to fill the transverse joint and the centerline joint. Reheated or overheated material shall not be used.

At the Contractor's option, the centerline joint may be sawed/formed and sealed in a manner similar to the transverse joint.

- (3) In Class C patches, transverse contraction joints shall be sealed according to Article 420.14(a).
- (4) Sealing of joints as specified in (1), (2), and (3) will not be required when patching is being performed to prepare the existing pavement for bituminous resurfacing.

442.07 Expansion Joints. Where expansion joints exist in the portion of the pavement that is to remain in place, the adjacent new pavement shall be constructed when possible with a similar type joint. Where existing joints are obsolete or

unobtainable, the expansion joint material may be any preformed expansion joint filler meeting the requirements of Section 1051.

In Class B patches, expansion joints shall be constructed as shown on the plans. The expansion joint materials shall conform to Article 1051.08 or 1051.09, and the joints shall be sealed as specified in Article 420.14(a).

442.08 Opening Patches to Traffic. The patches shall be opened to traffic according to Article 701.05(e).

442.09 Class D Patching. Class D patching shall conform to the standard details and cross sections shown on the plans. The materials and the methods of performing the work shall conform to Section 406 with the following exceptions:

- (a) **Barricading Patches.** Patches placed on roadways where the Traffic Control Plan permits an overnight lane closure, may remain closed until the following workday. On contracts on which overnight lane closure is not provided in the Traffic Control Plan, the removal and replacement of pavement shall be controlled by the Contractor so that all holes are filled and the compacted bituminous mixtures are cooled sufficiently to permit all barricades to be removed before dusk each day. The Contractor shall have the option of either stopping the patching early enough in the workday to permit the bituminous mixture to cool or use ice or water to induce early cooling.

Patches opened to traffic that are constructed high or become rough by rutting, shoving, or heaving shall be corrected within 48 hours by trimming off high areas and/or filling depressions. Filled areas shall be rerolled to obtain the required density.

Continued opening of the roadway before the bituminous mixture has cooled sufficiently to prevent rutting or shoving will be reason for the

Engineer to establish a shut-off time when all patch holes must be filled. No additional compensation will be allowed the Contractor if it is necessary for the Engineer to restrict the shut-off time.

- (b) **Pavement Removal.** This work shall conform to Article 442.05(c).
- (c) **Filling Holes.** Each properly prepared hole shall be filled with at least two layers of bituminous concrete mixture conforming to the requirements of Section 406 for bituminous concrete binder course. The bituminous concrete mixture shall be placed only when the temperature in the shade is at least 5 °C (40 °F) and the forecast is for rising temperature and when the subgrade is not frozen. Each layer shall be compacted with a mechanical tamper, a vibrating tamper, or a self-propelled roller. Trucks may be used to supplement the tampers or roller. If the required density is not obtained, the Contractor shall increase the number of layers and/or compactive efforts.

The top layer shall be not less than 50 mm (2 in.) compacted thickness. At the option of the Contractor, the 50 mm (2 in.) top layer may be constructed using bituminous concrete surface course. To facilitate possible extra

compaction and consolidation by traffic, the surface of the completed patch may be finished up to 13 mm (1/2 in.) above the existing pavement.

- (d) Density. After final compaction, the finished patch shall have a density of not less than 93 percent of the theoretical density of the mixture. The density of the bituminous mixture placed in patches shall be measured by nuclear test methods or obtained from specimens furnished by the Contractor according to the requirements of Article 406.16(b) except as hereinafter specified.
 - (1) Coring. The diameter of a core specimen shall in no case be less than 90 mm (3 5/8 in.). Two specimens shall be taken from each type of patch placed during a day and these shall be furnished not later than the morning of the first work day following placement of the patches. When directed by the Engineer, additional specimens shall be taken but the total number per day from each type of patch shall not exceed ten. The Contractor shall remove the specimens at locations designated by the Engineer and transport them to the plant laboratory. Care shall be exercised to avoid damage to the specimens. The holes caused by the removal of the specimens shall be refilled immediately with a bituminous material meeting these Specifications, compacted and finished to the satisfaction of the Engineer. The cost of this work will not be paid for separately, but shall be included in the unit prices bid for the item(s) of patching involved.
- (e) Additional Compaction. Traffic shall be permitted on the patches for at least three days prior to resurfacing.
- (f) Maintenance of Patch. The surface of the completed patch shall be maintained in a smooth condition. High spots shall be trimmed level with the pavement surface. If depressions develop, they shall be filled with a Surface Course or a B Binder Mixture compacted with a tandem or three-wheel roller. No additional compensation will be permitted for maintaining smooth patches.

If the patched pavement is to be resurfaced on the same contract, minor depressions in the patch surface may be filled and compacted as a part of the resurfacing operation.

442.10 Method of Measurement. Pavement removal and replacement of the various classes and types will be measured for payment in place, and the area computed in square meters (square yards).

To the extent possible, the contract documents contain information on the thickness of the existing pavement including subsequent resurfacing(s). In the event the average combined thickness of the existing pavement and overlays in an area to be patched differs from the thickness shown on the plans, the Engineer will adjust the patching quantity, for the specific patch type, and saw cut quantity of the individual patches meeting this requirement as indicated by the following chart. The quantities will be increased when the thickness is greater and decreased when the thickness is less.

<u>% change of thickness</u>	<u>% change of quantity</u>
0 to less than 15	0
15 to less than 20	10
20 to less than 30	15
30 and greater	20

No other compensation will be allowed for variations in patching thickness from that shown on the plans.

If additional pavement, subbase, or subgrade material is removed due to negligence on the part of the Contractor, the additional quantity of pavement removal and replacement or subgrade material will not be measured for payment. Shoulder removal and replacement resulting from edge forming will not be measured for payment.

When expansion joints are to be included in Class B patches, as shown on the plans or as directed by the Engineer, the expansion joint will be measured for payment in place in meters (feet).

Reinforcement bars will be computed in square meters (square yards) of surface area of the pavement patch in which the pavement reinforcement is installed, and no allowance will be made for laps, splices, or portions of bars not used.

Pavement fabric will be computed in square meters (square yards) of surface area of the pavement patch in which the pavement reinforcement fabric is installed.

All mandatory saw cuts for removal operations for Class A, Class B, or Class B (Hinge Jointed) patches will be measured for payment in place in meters (feet). Optional saw cuts with a concrete saw or wheel saw to aid the Contractor's removal operation will not be measured for payment. Optional wheel saw cuts allowed in lieu of mandatory saw cuts will be measured for payment as though the mandatory saw cuts were performed.

442.11 Basis of Payment. Where the Contractor has the option of using either Class C or Class D patches, this work will be paid for at the contract unit price per square meter (square yard) for PAVEMENT PATCHING, of the type and thickness specified.

Where the Department requires a specific class of patch be used, this work will be paid for at the contract unit price per square meter (square yard) for CLASS A PATCHES, CLASS B PATCHES, CLASS C PATCHES, OR CLASS D PATCHES of the type and thickness specified.

When expansion joints are included in Class B patches, the expansion joint will be paid for at the contract unit price per meter (foot) for CLASS B PATCH – EXPANSION JOINT. The deformed bars will be paid for at the contract unit price each for DEFORMED BARS – EXPANSION JOINT.

Where unsuitable material is encountered in the subgrade or subbase and its removal and replacement is required by the Engineer, such removal and replacement shall be performed by the Contractor and will be paid for according to Article 109.04.

Where damaged areas occur in the stabilized subbase as a result of the subbase adhering to the removed slab, the area shall be replaced with patch material by the Contractor and will be paid according to Article 109.04. Any removal or disposal costs for the additional material that adhered to the removed slab shall be included in the contract unit price for the item(s) of patching involved.

When additional pavement removal due to unsound concrete or deteriorated steel is directed by the Engineer, the additional quantities will be paid for according to Article 109.04.

Dowel bars will be paid for at the contract unit price each for DOWEL BARS of the diameter specified.

Pavement tie bars will be paid for at the contract unit price each for TIE BARS of the diameter specified.

Reinforcement bars will be paid for at the contract unit price per square meter (square yard) for PATCHING REINFORCEMENT.

Saw cuts will be paid for at the contract unit price per meter (foot) for SAW CUTS.

When pavement reinforcement fabric is included in the contract it will be paid for at the contract unit price per square meter (square yard) for PAVEMENT FABRIC. When pavement reinforcement fabric is required for patching, and a pay item is not included in the contract, the cost of the fabric will be paid for according to Article 109.04 of the Standard Specifications.

SECTION 443. REFLECTIVE CRACK CONTROL TREATMENT

443.01 Description. This work shall consist of constructing reflective crack control treatments of the type specified. Area reflective crack control treatment shall be either System A or C at the option of the Contractor. Strip reflective crack control treatment shall be either System A, B or C at the option of the Contractor.

443.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Reflective Crack Control System	1062

443.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Pressure Distributor	1102.05
(b) Mechanical Sweeper (Note 1)	1101.03
(c) Asphalt-Rubber Equipment (Note 2)	
(d) Cover Aggregate Spreader (Note 3)	
(e) Rolling Equipment (Note 4)	1101.01
(f) Mechanical Laydown Equipment (Note 5)	

Note 1. For pavement cleaning and excess cover aggregate removal.

Note 2. All equipment utilized in processing and application of the asphalt-rubber material shall be a truck or trailer mounted self-powered distributor equipped with a heating unit, a mixing unit capable of producing a homogenous mixture of asphalt and rubber, pump(s) capable of spraying asphalt-rubber within $\pm 0.22 \text{ L/sq m}$ ($\pm 0.05 \text{ gal/sq yd}$) of the specified rate, and a fully circulating spray bar capable of applying asphalt-rubber without a streaked or otherwise irregular pattern.

The distributor shall include a tachometer, pressure gages, volume measuring devices, an onboard weighing device to aid in proportioning materials and a thermometer. A "bootman" shall accompany the distributor and ride in a position so that all spray bar nozzles are in his/her full view and readily accessible for unplugging.

Note 3. The cover aggregate (chip) spreader shall be a self-propelled machine with an aggregate receiving hopper in the rear, belt conveyors to carry the aggregate to the front, and a spreading hopper equipped with full-width distribution auger and spread rolls. The spreader shall be in good mechanical condition and be capable of applying the cover material uniformly across the spread at the specified rate.

Note 4. Used for the required rolling of the cover material.

Note 5. Equipment shall be capable of handling full rolls of fabric, and shall be capable of laying the fabric smoothly without excessive wrinkles and/or folds.

Stiff brush brooms to smooth the fabric and scissors to cut the fabric shall be provided.

CONSTRUCTION REQUIREMENTS

443.04 Surface Preparation. The surface on which reflective crack control system is to be constructed shall be clean and dry. All base failures shall be repaired and all cracks, spalls, potholes or other depressions shall be sealed with an approved crack sealer or filled with mixture for cracks, joints and flangeways according to Article 406.06 and to the satisfaction of the Engineer before any crack control system is constructed. When, in the opinion of the Engineer, the existing pavement surface cannot be rendered sufficiently smooth, by crack sealing and patching, to receive the reflective crack control systems specified, a leveling binder shall be placed prior to construction of the reflective crack control system. The leveling binder shall be constructed according to Section 406.

443.05 Placing and Compaction of Bituminous Mixtures. Bituminous leveling binder, binder course or surface course mixtures placed on top of any reflective crack control system shall be placed at a maximum temperature of 150°C

(300 °F). All other preparation, transportation, placing and compaction of bituminous mixtures shall be done in conformance with Section 406.

443.06 Reflective Crack Control System A. The area to be covered with fabric shall be sprayed uniformly with asphalt binder at a rate of 1 to 1.3 L/sq m (0.25 to 0.30 gal/sq yd) as directed by the Engineer. Binder application shall be accomplished with a pressure distributor for all surfaces except, where the distributor does not have room to operate, hand spraying will be allowed. The width of the spray application shall be no more than 150 mm (6 in.) wider than the fabric and no less than the fabric width plus 50 mm (2 in.). The binder shall not be applied at a temperature greater than 160 °C (325 °F) to avoid damage to the fabric. After the binder has been sprayed, the fabric shall be unrolled or hand placed onto the binder without delay. Every effort must be made to lay the fabric as smoothly as possible to avoid wrinkles. Wrinkles large enough to cause laps of the fabric shall be cut and laid out flat. The fabric shall be broomed or squeegeed to remove air bubbles and make complete contact with the road surface.

The fabric shall overlap the adjacent fabric panel a minimum of 50 mm (2 in.). Additional asphalt binder shall be applied by hand to make the joints where overlap is greater than 50 mm (2 in.). The transverse joints shall be made in such a manner to avoid pickup by the paver. The direction of paving shall be in the direction of fabric placement.

When placed as a strip treatment, the strip shall be 600 mm (24 in.) wide.

443.07 Reflective Crack Control System B. The primer to be used with the waterproofing membrane shall be supplied by the manufacturer of the membrane and shall be compatible with the membrane.

The waterproofing membrane interlayer shall be placed as shown on the plans. Placement of the membrane shall be done only when the temperature is above 5 °C (40 °F) and the pavement surfaces are dry and free of dirt and debris.

The surface shall be primed according to the manufacturer's recommendations prior to placement of the membrane. The primer shall be placed on the concrete surface at a minimum rate of 7 sq m/L (300 sq ft/gal), shall extend 25 mm (1 in.) wider than the membrane, and shall be allowed to dry until tackfree before applying the membrane. Primer shall be placed on both portland cement concrete and asphaltic concrete pavement surfaces.

Any spall greater than 75 mm (3 in.) in diameter which will cause a failure of the material to bond to the pavement or will leave a cavity under the material shall be corrected prior to the placement of the waterproofing membrane interlayer.

The membrane shall be installed in nominal 300 mm (12 in.) widths [290 mm (11 3/8 in.) minimum] and shall be centered over the joint or crack within a 25 mm (1 in.) tolerance. Laps will be permitted in the membrane with a minimum overlap of 65 mm (2 1/2 in.). The membrane shall be installed straight and wrinkle-free with no curled or uplifted edges. Any wrinkles over 10 mm (3/8 in.) width shall be slit and folded down.

All membrane shall be surface dry before placement of the bituminous concrete overlay. Paving may begin immediately after membrane placement.

443.08 Reflective Crack Control System C. Immediately prior to application of a tack coat, the surface shall be thoroughly cleaned by sweeping.

When placed as a strip treatment, the strip shall be 600 mm (24 in.) wide. Also when placed as a strip treatment, a self-propelled distributor will not be required for applying the tack coat nor the asphalt-rubber, nor will a self-propelled spreader be required to place the cover aggregate. Equipment which meets the approval of the Engineer and applies a uniform application of tack coat, asphalt rubber and cover aggregate may be used.

- (a) Tack Coat. A tack coat of diluted emulsified asphalt, of the type and grade specified in Article 1062.03, shall be applied to the cleaned surface and allowed to fully cure before spreading of the asphalt rubber material. The emulsified asphalt shall be diluted one part water to one part emulsified asphalt by volume with from 0.4 to 0.6 L/sq m (0.10 to 0.15 gal/sq yd) of the diluted material applied.
- (b) Asphalt-Rubber Mixture. For the asphalt-rubber mixture, the Contractor has the choice of using either a vulcanized rubber in asphalt with a diluent (Mixture 1) or a crumb rubber blend in asphalt which has been treated with an extender oil (Mixture 2).
 - (1) Mixture 1. The percentage of vulcanized rubber shall be 33 ± 4 percent by mass (weight) of the asphalt cement in Mixture 1.

The temperature of the asphalt shall be between 175 °C (350 F) and 200 °C (395 °F) before addition of the vulcanized rubber. The material shall be carefully combined and mixed and reacted for a period of time as required by the Engineer which shall be based on laboratory testing by the asphalt-rubber supplier or contracting agency.

The temperature of the asphalt-rubber mixture shall be above 160 °C (325 °F) during the reaction period.

After the reaction between asphalt and rubber has occurred, the viscosity of the hot asphalt-rubber mixture may be adjusted for spraying and/or better "wetting" of the cover material by the addition of a diluent. The diluent shall not exceed 7 1/2 percent by volume of the hot asphalt-rubber mixture.

If a job delay results after the full reaction has occurred, the material may be allowed to cool and be slowly reheated to an acceptable spraying temperature just prior to application. However, because of the polymer reversion that can occur when crumb rubber is held for prolonged high temperatures, the material shall not be reheated to temperatures above 160 °C (325 °F). Additional diluent up to a maximum of three percent by volume of the hot asphalt-rubber mixture may be used after reheating of the material.

- (2) Mixture 2. The percentage of crumb rubber blend shall be 25 ± 4 percent by weight of the asphalt cement. Prior to adding the crumb rubber blend, the asphalt and extender oil shall be mixed in such quantities to produce an absolute viscosity of 6 Pa's (600 poises) at 60 °C (140 °F) when tested according to the requirements of AASHTO T 202. The asphalt oil blend shall first be heated to 200 °C (400 °F) minimum and be thoroughly mixed before beginning incorporation of the crumb rubber blend. The crumb rubber blend shall be added as quickly as possible and the mix shall be given adequate circulation and agitation during the addition-mixing process to provide for proper dispersion. As soon as the mixing of the rubber is complete, Mixture 2 may be applied to the roadway. However, if the material is not to be used within one hour of mixing, the temperature shall be reduced to below 160 °C (325 °F) and reheated on the project site.
- (c) Application of Asphalt-Rubber Material. Placement of the asphalt-rubber shall be made only under the following conditions:
- (1) The pavement surface temperature is not less than 15 °C (60 °F) and rain is not imminent.
 - (2) The pavement surface is clean and dry.
 - (3) The wind conditions are such that excessive blowing of the spray bar fans is not occurring, and
 - (4) All construction equipment such as asphalt-rubber distributor, aggregate spreader, haul trucks with cover aggregate, and rollers are in position and ready to commence placement operations.

The asphalt-rubber mixture shall be applied at a temperature of 140 °C - 160 °C (290 °F - 325 °F) at a rate of 2.5 ± 0.2 L/sq m (0.6 ± 0.05 gal/sq yd) [based on 0.9 kg/hot L (7 1/2 lb/hot gal)]. Transverse joints shall be constructed by placing building paper across and over the end of the previous asphalt-rubber application. Once the spraying has progressed beyond the paper, the paper shall be removed immediately and disposed of as directed by the Engineer. All longitudinal joints shall be lapped a minimum of 100 mm (4 in.).

- (d) Application of Cover Material. Cover material shall be applied immediately to the asphalt-rubber after spreading at a rate of 16 to 22 kg/sq m (30 to 40 lb/sq yd). If steel slag is used for cover material, the spread quantity shall be increased in proportion to its higher specific gravity.

At the time of application to the asphalt-rubber, cover aggregate shall not contain any free moisture.

- (e) Rolling. At least three pneumatic-tired rollers shall be provided to accomplish the required embedment of the cover material. At some project

locations or where production rates indicate, fewer rollers may be utilized as directed by the Engineer.

Sufficient rollers shall be used for the initial rolling to cover the width of the aggregate spread with one pass. The first pass shall be made immediately behind the aggregate spreader, and if the spreading is stopped for any reason, the spreader shall be moved ahead or off to the side so that all cover material may be immediately rolled. Four complete coverages with rollers shall be made with all rolling completed within two hours after the application of the cover material.

- (f) Opening the Completed Asphalt-Rubber Membrane Interlayer to Traffic. Except when it is necessary that hauling equipment must be on the newly applied membrane, traffic of all types shall be kept off the membrane until it has had time to set properly. The speed of all hauling equipment shall not exceed 25 km/h (15 mph) when traveling over a membrane which is not adequately set. The minimum traffic free period shall be not less than two hours.
- (g) Removing Loose Cover Aggregate. The sweeping shall be sufficient following placement of the membrane to remove all loose aggregate without dislodging any embedded aggregate.
- (h) Placement of Asphalt Concrete. The placement of the asphalt concrete overlay shall be delayed as directed by the Engineer for sufficient time to allow for adequate evaporation of the diluent or extender oil. A minimum of two hours shall elapse.

443.09 Method of Measurement. Area Reflective Crack Control Treatment will be measured for payment in place and the area computed in square meters (square yards). Strip Reflective Crack Control Treatment will be measured for payment in meters (feet) along the joint or crack parallel to the centerline of the pavement.

443.10 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for AREA REFLECTIVE CRACK CONTROL TREATMENT or per meter (foot) for STRIP REFLECTIVE CRACK CONTROL TREATMENT.

SECTION 444. FIBERGLASS FABRIC REPAIR SYSTEM

444.01 Description. This work shall consist of installation of a Fiberglass Fabric Repair System prior to placement of an asphalt overlay.

444.02 Materials. Materials shall conform to the requirements of Article 1063.

444.03 Equipment. Equipment shall consist of suitable sweepers, air compressors, hand brooms, pouring buckets, rubber-edged squeegees, cutting knives, and melting kettles. All hand tools shall be in a clean condition. Melting kettles shall be propane heated, with temperature controlling thermostat. Oil or kerosene fired, single jacketed kettles will not be allowed. The melting kettle shall be

clean and free from other bituminous materials which might change the properties of the specified Bituminous Adhesive. Since the adhesive is melted and used at higher temperatures than ordinary bituminous paving material, safety procedures concerning fire hazards and skin burns shall be observed.

CONSTRUCTION REQUIREMENTS

444.04 General. The existing pavement on which the Repair System is to be placed as marked by the Engineer shall be dry and free of dirt, rocks and other debris. All base failures shall be repaired and all cracks, spalls, potholes or other depressions shall be sealed with an approved crack sealer or primed and filled with Leveling Binder - Hand Method according to the applicable portions of Section 406 and to the satisfaction of the Engineer before the Repair System is constructed.

The Repair System shall be installed on a clean pavement. Cleaning shall be accomplished by suitable sweepers, compressed air or hand brooms. The specified Bituminous Adhesive, heated to $190^{\circ}\text{C} \pm 15^{\circ}\text{C}$ ($375^{\circ}\text{F} \pm 25^{\circ}\text{F}$), shall be applied by means of a hand spray bar or a pouring bucket and squeegee. The adhesive shall be squeegeed with sufficient uniformity to prevent streaking or ridging and shall extend a minimum of 25 mm (1 in.) beyond all edges of the fiberglass fabric. Following application of the adhesive on the pavement surface, the reinforcement fabric shall immediately be placed over it. If it is necessary to use two or more pieces of fabric to obtain the required width or length, the material shall be overlapped by a minimum of 50 mm (2 in.). Wrinkles in the fabric strips will not be permitted. Additional adhesive shall be squeegeed on top of the fabric and shall extend a minimum of 25 mm (1 in.) beyond all its edges. The application rate for two coats of Bituminous Adhesive in the system shall be a minimum of 3 L/sq m (0.70 gal/sq yd). When proper thickness is achieved, the weave pattern of reinforcement fabric shall be detectable through the top coat of the adhesive.

The Repair System shall be applied only when the ambient and pavement temperatures are at least 10°C (50°F) and rising. No materials shall be applied while the pavement surface is wet. The pavement surface shall be thoroughly dry before work begins.

The Repair System may be opened to construction traffic after a 30 minute minimum set time. The Contractor shall be responsible for the replacement of any damaged fabric at his expense prior to overlaying.

444.05 Method of Measurement. The Fiberglass Fabric Repair System will be measured for payment in place and the area computed in square meters (square yards) of fabric surface. No payments will be allowed for the fabric overlaps or the minimum extension of bituminous material beyond the edges of the fabric.

444.06 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for FIBER GLASS FABRIC REPAIR SYSTEM.

Leveling Binder (Hand Method) will be paid for as specified in Article 406.24.

SECTION 445. OPEN-GRADED ASPHALT FRICTION COURSE

445.01 Description. This work shall consist of the construction of an Open-Graded Asphalt Friction Course (OGAFC) on a new bituminous concrete binder course.

445.02 Materials. Materials shall meet the following requirements of Section 1000 - Materials:

Item	Article/Section
(a) Coarse Aggregate (Note 1)	1004.03
(b) Fine Aggregate	1003.03
(c) Mineral Filler	1011
(d) Bituminous Material (Note 2).....	1009

Note 1. Coarse Aggregate. Any of the following coarse aggregates may be used to produce OGAFC mixtures.

- (1) Description.
 - a. Crushed Steel Slag. Crushed steel slag shall be the graded product resulting from the processing of steel slag from an open-hearth or basic-oxygen furnace.
 - b. Crushed Slag.
 - c. Crushed Trap Rock.
 - d. Crushed Sandstone.
- (2) Quality. The aggregate shall have Class B quality or better meeting the requirements of Article 1004.01(b), except the Los Angeles Abrasion Test, AASHTO T 96, does not apply to crushed slag aggregate.
- (3) Gradation. The coarse aggregates shall be uniformly graded from coarse to fine and when tested by means of laboratory sieves (square openings) shall conform to the following gradation. A maximum of 20 percent fine aggregate may be blended with the coarse aggregate to obtain the required gradation.

Passing 12.5 mm (1/2 in.) sieve	100%
Passing 9.5 mm (3/8 in.) sieve	90-100%
Passing 4.75 mm (No. 4) sieve	30-50%
Passing 2.36 mm (No. 8) sieve	10-18%
Passing 75 µm (No. 200) sieve	2-5%

Note 2. Asphalt cement grade PG58-22 or PG64-22 shall be used. The grade to be used will be as shown on the plans. The Contractor shall use an approved heat-stable anti-stripping additive. The anti-stripping additive shall meet the approval of the Engineer based on the results of laboratory tests conducted by the Bureau of Materials and Physical Research. The additive shall be added to the asphalt tank at the recommended dosage [0.5 to 1.0

percent by mass (weight) of asphalt cement] and thoroughly mixed by circulation of the asphalt for at least four hours prior to being incorporated into the mix. The exact amount of additive will be determined by the Engineer based on laboratory tests.

445.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Self-propelled Pneumatic-Tired Roller (Note 1)	1101.01
(b) Three-Wheel Roller (Note 2)	1101.01
(c) Tandem Roller (Note 3)	1101.01
(d) Hot-Mix Plant (Note 4)	1102.01
(e) Spreading and Finishing Machine (Note 5)	1102.03
(f) Pressure Distributor	1102.05
(g) Heating Equipment	1102.07
(h) Trench Roller	1101.01
(i) Vibratory Roller	1101.01

Note 1. The self-propelled pneumatic-tired roller shall develop a compression of not less than 53 N/mm (300 lb/in.) nor more than 88 N/mm (500 lb/in.) of width of the tire tread in contact with the bituminous surface. The tires shall be inflated to an air pressure of not less than 550 kPa (80 psi).

Note 2. The three-wheeled roller shall weigh 9 metric tons (10 tons) to 11 metric tons (12 tons) and shall have a unit compression on the drive wheels of not less than 53 N/mm (300 lb/in.) nor more than 70 N/mm (400 lb/in.) of roller width.

Note 3. The tandem roller shall weigh 7 metric tons (8 tons) to 11 metric tons (12 tons) and shall have a unit compression on the drive wheels of not less than 44 N/mm (250 lb/in.) to 70 N/mm (400 lb/in.) of roller width.

Note 4. The hot-mix plant shall be a batch type plant.

Note 5. The spreading and finishing machine shall be equipped with either a mechanical leveling device or an automatic electronic grade as specified in Article 1102.03.

CONSTRUCTION REQUIREMENTS

445.04 General. Article 406.04 shall apply except the mixture shall be placed only when the daily high air temperature is at least 15 °C (60 °F) two days prior to placement and there is a forecast of high temperature of at least 15 °C (60 °F) during and for two days after construction. Official National Weather Service data for the construction area shall be used.

445.05 Keeping Road Open to Traffic. Article 701.05(c)(3) shall apply.

445.06 Preparation, Priming and Leveling of Existing Bituminous Concrete Surfaces. Prior to placing OGAFC directly over an existing bituminous concrete surface, the existing surface shall be leveled. The preparation, priming and leveling of the existing surface shall be accomplished, measured and paid for according to the applicable portions of Section 406.

445.07 Preparation of Mineral Aggregates, Asphalt Cement and Bituminous Mixtures. Preparation of asphalt cement shall be according to Article 406.08. Preparation of mineral aggregates be according to Article 406.09 except the aggregates shall be heated in such a manner as to assure that the mixing temperature is uniformly maintained. The aggregates shall be dried to less than 0.5 percent residual moisture by weight, as determined by hot bin samples. This may require the aggregate to be processed twice through the drier. The aggregate(s) shall be screened into at least two sizes before mixing.

Preparation of bituminous mixtures shall conform to Article 406.12 except the mixing temperature shall not exceed 125 °C (260 °F).

445.08 Mixing Formula. At least two weeks prior to the placement of any of these mixtures, the Contractor shall furnish to the Engineer samples of the aggregates he proposes to use. The Engineer shall perform mix design tests to determine the exact proportions for the mix which will be between the following composition limits by weight:

Aggregate	85-95%
Asphalt Cement (Note 1)	5-15%

Note 1. The range of asphalt content is based on the varying physical properties of the coarse aggregate that can be used for the manufacture of OGAFC. Upon request, the Engineer will provide the Contractor with an approximate asphalt content, ± 1 percent, for any given coarse aggregate. The amount of anti-stripping agent will not be included in this percentage.

445.09 Transportation. These mixtures shall be transported in covered and insulated trucks conforming to Article 406.14. The cover shall be rolled back before the load is dumped into the finishing machine. Covering may be waived on short hauls or in hot weather.

445.10 Placing. Article 406.15 shall apply except for the following:

- (a) The mixture shall be at a temperature of $110^{\circ}\text{C} \pm 10^{\circ}\text{C}$ ($230^{\circ}\text{F} \pm 20^{\circ}\text{F}$) at the time of placement.
- (b) The mix shall be placed within one hour from the time of completion of mixing.
- (c) No straightedging will be required.
- (d) The paver speed shall be limited to not more than 10 m/min (35 ft/min).

- (e) The mix shall be placed only at a uniform nominal thickness of 15 mm (5/8 in.) compacted.

Note: Approximate unit weights for Open-Graded Asphalt Friction Course mixtures are:

- (1) Crushed Steel Slag - 40 kg/sq m (75 lb/sq yd) at 15 mm (5/8 in.) thickness.
- (2) Crushed Slag - 30 kg/sq m (56 lb/sq yd) at 15 mm (5/8 in.) thickness.
- (3) Crushed Trap Rock - 35 kg/sq m (66 lb/sq yd) at 15 mm (5/8 in.) thickness.

445.11 Compaction. Immediately after placement of the mixtures, the pavement shall be compacted by two tandem rollers. No more than a total of three coverages by the rollers will be required. When approved by the Engineer, vibratory rollers may be used in the static mode. More than three coverages may be required when using vibratory rollers due to lower unit weights. The Engineer may eliminate one roller on small jobs. The amount of rolling shall be confined to only that necessary for consolidating the bituminous mixture and bonding it to the underlying surface. Excessive rolling shall be avoided.

445.12 Protection. No traffic shall be allowed on any portion of the completed pavement until after the final rolling and the mixture has cooled adequately to prevent pickup.

445.13 Method of Measurement. Open-Graded Asphalt Friction Surface Course will be measured for payment in place and the area computed in square meters (square yards). The width used shall be that which is shown on the plans.

445.14 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for OPEN-GRADED ASPHALT FRICTION SURFACE COURSE.

SECTION 446. PAVEMENT REHABILITATION BY THE HEAT-SCARIFY-OVERLAY METHOD

446.01 Description. This work shall consist of rehabilitating an asphalt pavement by heating, scarifying, reshaping and rejuvenating the surface with the addition of a new bituminous concrete surface according to the thickness specified on the plans.

CONSTRUCTION REQUIREMENTS

446.02 General. The entire surface to be rehabilitated shall be free of water, earth and foreign material. All base failures shall be repaired prior to the heating-scarifying process according to Section 358. Rehabilitation work shall be performed

Art. 446.03 Pavement Rehabilitation by the Heat-Scarify-Overlay Method

only when the air temperature in the shade is at least 7 °C (45 °F) and the forecast is for rising temperatures.

The surface of the existing pavement shall be heated with a continuously moving heater to allow the pavement to be scarified to a 20 mm (3/4 in.) average depth with the surface temperature of the old pavement not to exceed 190 °C (375 °F). Scarification of 20 mm (3/4 in.) will yield an approximate weight of 45 kg/sq m (9 lb/sq ft) of loose material. Heat shall be applied under an enclosed or shielded hood and shall extend at least 100 mm (4 in.) beyond the width of scarification on both sides. Scarifying shall be accomplished with pressure scarifiers. The scarifying unit shall be equipped to scarify and move material away from the gutter flags for a depth of 13 mm (1/2 in.) by 100 mm (4 in.) wide. The heating-scarifying operation shall not exceed 10 m (30 ft) per minute. When a repaving pass is being made adjacent to a previously placed mat, the longitudinal repaving seam shall extend at least 50 mm (2 in.) into the previously placed mat.

Immediately after the scarifying operation, an asphalt modifier approved by the Bureau of Materials and Physical Research shall be applied at the rate of 0.5 L/sq m (0.10 gal/sq yd). The Engineer may waive or adjust the requirement for the asphalt modifier if the existing pavement condition warrants this action. The surface shall then be leveled by distributing the heated, scarified and treated (HST) material over the width being processed so as to produce a uniform cross section. The minimum temperature of the HST material after leveling shall be 80 °C (175 °F). If the new bituminous mixture is to be placed later as a separate operation, the HST material shall be compacted before the temperature of the mix drops below 65 °C (150 °F). Compaction shall be accomplished with a self-propelled pneumatic-tired roller meeting the requirements of Articles 1101.01(c) and 406.16(a).

Within 48 hours of the HST operation, a uniform layer of not less than 40 kg/sq m (70 lb/sq yd) of bituminous surface course mixture meeting the requirements of Section 406 for Class I, Type 3, shall be placed with a spreading and finishing machine meeting the requirements of Article 1102.03. Whenever the layer is between 40 kg/sq m (70 lb/sq yd) and 75 kg/sq m (140 lb/sq yd), CA 16 gradation will be required. The spreading and finishing machine shall be capable of spreading and finishing the surface in lane widths to the specified cross section and thickness. The activated screed or strikeoff assembly shall effectively produce a finished surface of the required uniform slope and texture without tearing, shoving or gouging the mix. The screed shall be adjustable to taper the finished surface to the height of the gutter flag. The surface shall be compacted thoroughly and uniformly with a pneumatic-tired roller followed by a tandem finish roller meeting the requirements of Articles 1101.01(c), 1101.01(e) and 406.16(a). The forward speed of the spreading and finishing machine shall insure, as near as possible, a continuous operation but shall not exceed 10 m (35 ft) per minute.

446.03 Method of Measurement.

- (a) Contract Quantities. The requirement for use of contract quantities shall be according to Article 202.07(a).
- (b) Measured Quantities. The heat-scarifying process will be measured for payment in place and the area computed in square meters (square yards).

The asphalt modifier will be measured for payment in liters (gallons) according to Article 1009.03. The hot bituminous surface mixture will be measured for payment in metric tons (tons) according to Article 406.23.

446.04 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for HEAT-SCARIFYING, per metric ton (ton) for HOT BITUMINOUS SURFACE MIXTURE and per liter (gallon) for ASPHALT MODIFIER.

If provided as a pay item, the preparation of the base will be paid for according to Article 358.07. If not provided as a pay item, preparation of the base, including additional material required, shall be considered as included in the contract unit price bid for Heater-Scarifying, and no additional compensation will be allowed.

SECTION 447. SINGLE PASS ASPHALT REPAVING

447.01 Description. This work shall consist of repaving the existing asphalt pavement in a continuous multi-step process of heating, scarifying and rejuvenating the old asphalt surface with the addition of a new asphalt mixture to form a bituminous concrete surface of the required thickness as specified on the plans.

CONSTRUCTION REQUIREMENTS

447.02 General. The entire surface to be repaved shall be cleaned of water, earth and foreign material. All base failures shall be repaired prior to the repaving process according to Section 358. Asphalt repaving shall be performed only when the air temperature in the shade is at least 7 °C (45 °F) and the forecast is for rising temperatures.

The surface of the existing pavement shall be heated with a continuously moving heater to allow the pavement to be scarified to a 20 mm (3/4 in.) average depth with the surface temperature of the old pavement not to exceed 190 °C (375 °F). Scarification of 20 mm (3/4 in.) will yield an approximate weight of 45 kg/sq m (9 lb/sq ft) of loose material. Heat shall be applied under an enclosed or shielded hood. When abutting a bituminous concrete mat, the heating operation shall extend at least 100 mm (4 in.) beyond the width of scarification on both sides.

Scarifying shall be accomplished with pressure loaded scarifiers. The scarifying unit shall be so equipped to scarify and move material away from the gutter flags for a depth of 15 mm (1/2 in.) by 100 mm (4 in.) wide. When a repaving pass is being made adjacent to a previously placed mat, the longitudinal repaving seam shall extend at least 50 mm (2 in.) into the previously placed mat.

After the scarifying operation and prior to mixing, an asphalt modifier approved by the Bureau of Materials and Physical Research shall be applied at the rate of 0.5 L/sq m (0.10 gal/sq yd). The engineer may waive or adjust the requirement for the asphalt modifier if the existing pavement condition warrants this action.

The heated-scarified mix with modifier shall then be processed by one of the following methods:

- (a) After the addition of the modifier, the heated-scarified material shall be mixed either by an auger or mixing unit and then distributed over the width of the pavement by a leveling unit to produce a uniform cross section. The leveling device shall have the capability of windrowing excess material to one side for removal when necessary. The minimum temperature of the processed mix as it leaves the leveling unit shall be 80 °C (175 °F). The minimum depth of processed mix laid as a leveling course shall be 13 mm (1/2 in.). Immediately after reshaping the processed mix, a uniform layer of not less than 40 kg/sq m (70 lb/sq yd) of new surface course mixture meeting the requirements of the applicable portions of Section 406 for Class I, Type 3, shall be applied by a vibratory screed or strike-off assembly, heated if necessary. The machine shall be capable of spreading and finishing the surface in lane widths to the specified section and thickness. The vibratory screed or strike-off assembly shall effectively produce a finished surface of the required uniform slope and texture without tearing, shoving or gouging the mix. The outside section of the screed shall be adjustable to taper the finished surface to the height of the gutter flag. The surface shall be compacted thoroughly and uniformly with a pneumatic-tired roller followed by a tandem roller meeting the requirements of Articles 1101.01(c) and 1101.01(e). The complete repaving operation shall not exceed 9 m (30 ft) per minute.
- (b) After the addition of the modifier, the heated-scarified material shall be mixed either by auger or mixing unit. Virgin mix, meeting the applicable requirements of Section 406 of the Standard Specifications, shall be added to the mixing operation at this time at a rate of not less than 40 kg/sq m (70 lb/sq yd) of finished pavement. The processed mixture shall then be distributed over the width of the pavement by a vibratory screed or strike-off assembly, heated if necessary. The machine shall be capable of spreading and finishing the surface in lane widths to the specified section and thickness. The vibratory screed or strike-off assembly shall effectively produce a finished surface of the required uniform slope and texture without tearing, shoving or gouging the mix. The outside section of the screed shall be adjustable to taper the finished surface to the height of the gutter flag. The surface shall be compacted thoroughly and uniformly with a pneumatic-tired roller followed by a tandem roller meeting the requirements of Articles 1101.01(c), 1101.01(e), and 406.16(a). The completed paving operation shall not exceed 9 m (30 ft) per minute. The minimum temperature of the processed mixture behind the paver shall be 110 °C (225 °F). The minimum compacted depth of processed mix laid shall be 30 mm (1 1/4 in.).

447.03 Method of Measurement. The repaved surface will be measured for payment in place and the area computed in square meters (square yards). Hot bituminous surface mixture will be measured for payment in metric tons (tons) according to Article 406.23. Asphalt modifier will be measured for payment in liters (gallons) according to Article 1009.03.

447.04 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for REPAVING, per metric ton (ton) for HOT BITUMINOUS SURFACE MIXTURE, and per liter (gallon) for ASPHALT MODIFIER.

If provided as a payment item, the preparation of the base will be paid for as specified in Article 358.07. If not provided as a payment item, the preparation of the base shall be considered as included in the contract unit price bid for Repaving, and no additional compensation will be allowed.

SECTION 448. MICRO-SURFACING

448.01 Description. This work shall consist of a latex modified asphalt pavement course to fill ruts and/or provide a wearing course for existing pavements.

448.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Aggregate (Note 1)	
(b) Mineral Filler (Note 2)	1001
(c) Water	1002
(d) Latex Modified Emulsified Asphalt	1009.07

Note 1. The aggregate shall be 100 percent crushed material and shall be crushed limestone, crushed dolomite, crushed sandstone, crushed air-cooled blast furnace slag, or crushed gravel, Class A quality meeting the gradation limits in the Table below and the physical properties of Article 1003.01. When used as a surface course, the aggregate shall conform to the friction requirements of the Department's "Skid Accident Reduction Program".

Gradation Limits for Aggregate

<u>Percent Passing Sieve</u>	<u>Surface Mix</u>	<u>Rutfill Mix</u>
12.5 mm (1/2 in.)	100	100
9.5 mm (3/8 in.)	100	90 - 100
4.75 mm (No. 4)	85 - 100	55 - 75
2.36 mm (No. 8)	50 - 80	40 - 55
1.18 mm (No. 16)	40 - 65	25 - 40
600 µm (No. 30)	25 - 45	19 - 34
300 µm (No. 50)	13 - 25	10 - 20
75 µm (No. 200)	5 - 15	4 - 10

Note 2. Mineral filler shall be Type 1 portland cement.

448.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Micro-Surfacing Mixing Machine	1102.11
(b) Micro-Surfacing Spreader	1102.12

CONSTRUCTION REQUIREMENTS

448.04 General. The paving mixture shall be capable of filling up to 40 mm (1 1/2 in.) wheel ruts in one pass, be capable of field regulation of the setting time, and be suitable for nighttime placement. The compatibility of all ingredients of the mix, including the mix set additive, shall be certified by the emulsified asphalt manufacturer.

448.05 Proportioning. An independent laboratory provided by the Contractor shall develop the Job Mix Formula (JMF) for the paving mixture, shall verify the functioning of the set regulating additives, and shall present certified test results for the Engineer's approval. The JMF shall have a minimum Marshall Stability of 8 kN (1,800 lb) and a flow of 1.5 to 4 mm (6 to 16 units) when tested according to ASTM D 1559 except air drying of the mixture at 20-25 °C (70-75 °F) for three days before reheating and placing the material in the test molds will be permitted. Aggregate in the mixture shall represent material to be used on the project.

Proportions for the JMF shall be within the following limits:

Mineral Aggregate, dry mass (weight) kg/sq m (lb/sq yd)	8-30 (15-50)
Latex Emulsified Asphalt Residue, % by wt. of Aggregate	6.0-8.0
Latex Base Modifier	As required with % by mass (weight) of Binder min. of 2.5
Mix Set Additive	As required
Mineral Filler, % by mass (weight) of Aggregate	0.5-2.5, depending on weather conditions

The Engineer shall approve the JMF prior to its use. After approval, the Contractor shall maintain continuous control of the latex modified emulsified asphalt to dry aggregate proportioning to conform to the approved JMF within a tolerance of ± 8 L/metric ton (± 2 gal/ton).

448.06 Weather Limitations. The mixture shall be placed only when it is not raining, and when the temperature is at least 5 °C (40 °F) and rising and the forecast for the next 24 hours is above 0 °C (32 °F). Applications after October 31 and before March 31 will not be permitted when the temperature is less than 10 °C (50 °F).

448.07 Surface Preparation. Prior to applying the mixture, the Contractor shall clean the surface by removing vegetation, loose materials, dirt, mud and other objectionable materials. Water shall be misted on the existing pavement surface immediately prior to applying the asphalt mixture. A tack coat will be required on portland cement concrete surfaces. The tack coat shall be limited to emulsified asphalts as outlined in Article 406.02 and shall be applied at a rate of 0.22-0.45 L/sq m (0.05-0.10 gal/sq yd) according to Article 406.06(b).

448.08 Application. If rut filling is called for on the plans, the micro-surfacing shall be performed in two operations. The first operation shall include filling each of the two wheelpath ruts in a lane using the specially designed rutbox and the rutfill

mix. The second operations shall include a simple application of the surface mix over the entire width of the lane and spread at a rate to provide a minimum of 8 kg/sq m (15 lb/sq yd) of aggregate (dry weight) in the mixture. It shall be the Contractor's responsibility to determine and estimate the quantities of rutfill mix required for rut filling.

For other than rut filling, the micro-surfacing shall consist of the application of the surface mix over the entire width of each lane in two passes to provide a total rate of application of not less than 16 kg/sq m (30 lb/sq yd) of aggregate (dry weight) in the mixture. The rate of application per pass may vary somewhat from one half the total minimum rate at the option of the Contractor. For example, the Contractor may choose to place the surface mixture at a rate to provide 6.5 kg/sq m (12 lb/sq yd) of aggregate (dry weight) on the first pass and 10 kg/sq m (18 lb/sq yd) on the second pass. Unless otherwise directed by the Engineer, all hand work shall be completed during the first pass.

Determinations of application rates shall be from daily readings taken from the material control devices during the progress of the work.

Micro-surfacing edges shall be parallel with the existing pavement edges. If the existing pavement edge cannot be used to give a straight edge, a string line or other guide will be required.

The paving mixture shall be spread to fill minor cracks and shallow potholes and leave a uniform surface. Care shall be taken when rut filling to restore the designed profile of the pavement cross section. Excess crowning (over-filling) of rut areas shall be avoided. A sufficient amount of material shall be carried at all times in all parts of the spreader box to ensure complete coverage. No lumps or unmixed aggregate will be permitted in the finished surface.

A smooth, neat seam shall be provided where two passes meet. Excess material shall be immediately removed from the ends of each run. Any damage to, or irregularities in, the micro-surfacing shall be repaired by the Contractor at his/her own expense, as directed by the Engineer. All repairs shall be made with a paver box, except areas designated as hand work areas.

Those areas inaccessible to the spreader box and other areas approved by the Engineer shall be designated as hand work areas. Adjustments to the additive are permitted to provide a slower setting time when hand spreading is needed. If hand spreading is necessary, the mixture shall be poured in a small windrow along one edge of the surface to be covered and then spread uniformly by a hand squeegee or lute.

448.09 Sampling and Testing. The Contractor shall be responsible for all sampling and testing, and for furnishing all test results to the Engineer. The Contractor, in the presence of the Engineer, shall take a minimum of two samples per day for extraction/gradation analyses. The samples shall be taken from the pug mill discharge chute using a rectangular non-absorptive container, such as a loaf pan, of sufficient size to obtain a sample from the entire cross section of the mixture being discharged. Each sample should weigh from 1000 to 1500 g (2.5 to 4 lb). Each sample shall be tested to determine the asphalt content and gradation of aggregate in

Art. 449.01 Removal and Replacement of Preformed Elastomeric

the mixture. The testing shall be performed according to the requirements of the Department's "Manual of Instructions for Bituminous Proportioning and Testing".

448.10 Opening to Traffic. Micro-surfacing shall be capable of producing an emulsified asphalt paving mixture that will cure at a rate which will permit traffic on the pavement within one hour after application without damaging the pavement surface. Any damage done by traffic to the micro-surfacing shall be repaired by the Contractor at his/her expense.

448.11 Method of Measurement.

- (a) **Contract Quantities.** The requirements for the use of contract quantities shall conform to Article 202.07(a).
- (b) **Measured Quantities.** When rut filling is called for, micro-surfacing for the surface mix placed in one pass will be measured for payment in place and the area computed in square meters (square yards). The width for measurement will be the width of the top surface as shown on the plans or as directed by the Engineer. Micro-surfacing for rut filling will be measured for payment in place in meters (feet) along the wheel path or filled rut.

For other than rut filling. The plans, micro-surfacing for the surface mix placed in two passes will be measured for payment in place as specified above for the surface mix placed in one pass.

448.12 Basis of Payment. When rut filling is called for, this work will be paid for at the contract unit price per square meter (square yard) for MICRO-SURFACING 1 PASS and per meter (foot) for MICRO-SURFACING RUT FILLING.

When rut filling is not needed or called for on the plans, this work will be paid for at the contract unit price per square meter (square yard) for MICRO-SURFACING 2 PASSES.

SECTION 449. REMOVAL AND REPLACEMENT OF PREFORMED ELASTOMERIC COMPRESSION JOINT SEAL

449.01 Description. This work consists of removing the existing joint seal and replacing it with a new preformed elastomeric compression joint seal of the size shown in the plan details and as directed by the Engineer.

449.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Preformed Elastomeric Joint Seal for Concrete	1053

449.03 Equipment. The machine used to cut the joints shall be an approved concrete saw. Routers or saws which produce rough and raveled joint faces will not be allowed. The machine shall also be capable of cutting a uniform shape in a straight manner so that the seal will seat properly in the joint.

CONSTRUCTION REQUIREMENTS

449.04 General. The existing joint seal shall be removed prior to reshaping the joint or shall be saw cut out during reshaping of the joint. The preformed elastomeric compression joint seal shall be installed in a clean joint according to Article 420.14(b).

449.05 Method of Measurement.

- (a) Contract Quantities. The requirement for use of contract quantities shall be according to Article 202.07(a).
- (b) Measured Quantities. Removal and replacement of preformed elastomeric compression joint seal will be measured for payment in meters (feet), measured along the joint.

449.06 Basis of Payment. Removal and replacement of preformed elastomeric compression joint seal will be paid for at the contract unit price per meter (foot) for REMOVAL AND REPLACEMENT OF PREFORMED ELASTOMERIC COMPRESSION JOINT SEAL, which price shall include all work specified.

SECTION 450. RELIEF JOINT

450.01 Description. This work shall consist of removing the existing pavement to the width specified, installing a preformed expansion joint filler and sealing as specified herein.

450.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Hot Poured Joint Sealer	1050.02
(b) Preformed Expansion Joint Filler	1051.08

450.03 Equipment.

- (a) Concrete Saw. Concrete saws shall be equipped with a diamond blade of sufficient size to saw pavements full-depth and be capable of accurately maintaining cutting depth and alignment.
- (b) Wheel saw. Wheel saws shall be equipped with carbide tipped rotating cutters and be capable of accurately maintaining cutting depth and alignment.
- (c) Heating Equipment for Joint Sealant. The heating equipment shall be of an indirect heating type with positive temperature control, mechanical agitation and recirculating pumps.

CONSTRUCTION REQUIREMENTS

450.04 General. The relief joint shall be formed by full-depth sawing of the existing pavement. The joint shall be straight and perpendicular to the centerline, with a tolerance of 40 mm in 3.6 m (1 1/2 in. in 12 ft). Concrete not sawed full depth shall be removed with hand tools.

Prior to installing the preformed expansion joint filler, the sawed faces of the pavement shall be cleaned with compressed air. If the sawing operation disturbs or displaces the subbase, the disturbed subbase shall be removed and replaced with compacted FA-1 or FA-2 to the bottom of the existing pavement.

The preformed expansion joint filler shall be installed in a compressed condition in the sawed joint. The method used shall minimize damage to the filler.

The hot poured joint sealer shall be installed as shown on the plans and in the saw cut extensions. Poured joint sealing material shall be placed according to Article 420.14(a). The joint sealer shall cure to the satisfaction of the Engineer prior to opening to traffic.

Wheel saw cut extension or other large areas removed from the shoulders shall be replaced with the same material as in the existing shoulder before opening to traffic.

450.05 Method of Measurement. This work will be measured for payment in meters (feet) along the joint from edge to edge of pavement.

450.06 Basis of Payment. This work will be paid for at the contract unit price per meter (foot) for RELIEF JOINT of the width specified. If the sawed joint closes and the Engineer requires resawing the joint, this resawing will be paid for according to Article 109.04.

SECTION 451. CRACK SEALING BITUMINOUS PAVEMENT

451.01 Description. This work shall consist of routing, cleaning and sealing transverse and longitudinal reflected cracks in the existing bituminous pavement.

451.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Hot Poured Joint Sealer	1050.02

451.03 Equipment. The routing machine to be used for routing cracks and joints shall have a cutter that consists of radially located steel cutters mounted on a circular cutter head. The routing machine shall also be capable of cutting a uniform square shape approximately 20 mm by 20 mm (3/4 in. by 3/4 in.) in either a straight or irregular line. A double-jacketed kettle shall be used for heating the sealer.

CONSTRUCTION REQUIREMENTS

451.04 General. Primary transverse and longitudinal working cracks shall be routed, cleaned and sealed. Any adjacent secondary cracks shall be only cleaned and sealed as directed by the Engineer.

Cracks shall be routed following the crack as nearly as possible, approximately 20 mm (3/4 in.) wide by 20 mm (3/4 in.) deep as close to a 1:1 ratio as possible. Immediately ahead of sealer placement, dust and debris shall be blown from the crack with a power brush/blower or with compressed air with a minimum pressure of 620 kPa (90 psi). If compressed air is used, the pneumatic tool lubricator must be bypassed and a filter installed on the discharge valve to keep water and oil out of the lines.

The sealant shall be applied using the methods and equipment recommended by the sealant manufacturer. Hot asphalt sealer shall be continuously, mechanically agitated during heating so that localized heating does not occur. Poured crack sealer shall not be placed when the air temperature in the shade is less than 4 °C (40 °F).

Existing raised reflective pavement markers shall be protected during the crack sealing operations. Tracking of bituminous materials or other sealant material will not be allowed. If bituminous materials or other sealant materials are applied to the markers, either by accident or because of inadequate protection, the Contractor shall remove such material to the satisfaction of the Engineer:

Sealant shall be placed in the clean, dry crack. The crack shall be slightly overfilled and immediately squeegeed to provide a "band-aid" type effect approximately 50 mm (2 in.) wide flush with the pavement surface with the edges feathered out.

The sealant shall be allowed to cure before opening to traffic. The sealant should be tack free in about ten minutes. When necessary, the sealant may be dusted with fine sand, portland cement or mineral filler, or covered with tissue paper to prevent tracking.

451.05 Method of Measurement.

- (a) Crack Routing. Routed cracks will be measured for payment in meters (feet), measured along the routed crack.
- (b) Crack Filling. Filling of cracks will be measured for payment in kilograms (pounds) of sealant used. The cost of cleaning the crack shall be included in the price bid for crack filling. The quantity of sealant used will be determined by counting the containers of sealant used, multiplied by the indicated kilograms (pounds) of each container.

451.06 Basis of Payment. This work will be paid for at the contract unit price per meter (foot) for CRACK ROUTING (PAVEMENT) and at the contract unit price per kilogram (pound) for CRACK FILLING.

SECTION 452. CRACK AND JOINT SEALING PORTLAND CEMENT CONCRETE PAVEMENT

452.01 Description. This work consists of routing, cleaning and sealing longitudinal shoulder joints, transverse and longitudinal random cracks, centerline joints, contraction joints and transverse expansion joints in portland cement concrete pavement.

452.02 Materials. Materials shall meet the requirements of the following Article of Section 1000 - Materials:

Item	Article/Section
(a) Hot Poured Joint Sealer	1050.02

452.03 Equipment. The routing machine to be used for routing cracks and joints shall have a cutter that consists of radially located steel cutters mounted on a circular cutter head. The routing machine shall also be capable of cutting a uniform square shape approximately 20 mm by 20 mm (3/4 in. by 3/4 in.) in either a straight or irregular line. A double-jacketed kettle shall be used for heating the sealer.

CONSTRUCTION REQUIREMENTS

452.04 General. The longitudinal shoulder joint between the edge of pavement and the newly placed bituminous shoulder, the transverse and longitudinal random cracks in other than continuously reinforced portland cement concrete pavement, contraction joints and the centerline joints shall be routed or sawed to approximately 20 mm (3/4 in.) wide by 20 mm (3/4 in.) deep as close to a 1:1 ratio as possible. When routing or sawing the longitudinal shoulder joint, the router or saw used shall be capable of following the path of the joint without causing excessive spalling or damage to the adjacent rigid pavement. If old sealants are present in the joint or crack, they shall be removed prior to routing or sawing.

Immediately ahead of the sealer placement, dust and debris shall be blown from the joint or crack with a power brush/blower or with compressed air at a minimum pressure of 620 kPa (90 psi). If compressed air is used, the pneumatic tool lubricator must be bypassed and a filter installed on the discharge valve to keep water and oil out of the lines.

Hot asphalt sealer shall be continuously, mechanically agitated during heating so that localized heating does not occur. Poured crack sealer shall not be placed when the air temperature in the shade is less than 4 °C (40 °F).

Areas along the longitudinal shoulder joint, the transverse and longitudinal random cracks (where applicable), the contraction joint or centerline where a void exists that exceeds 20 mm (3/4 in.) depth shall be provided with a backer rod to control the depth of sealant. The void shall be routed (if necessary) to provide a depth from the top of the backer rod to the top of the pavement of 20 mm (3/4 in.).

The areas where backer rod will be required shall be as directed by the Engineer. The backer rod diameter shall be 3 mm (1/8 in.) wider than the routed

joint. The backer rod shall be a closed-cell, plastic-foam, heat resistant, chemically inert, waterproof, rod compatible with the sealant used.

Sealant shall be placed in the clean, dry crack or joint. The crack or joint shall be slightly overfilled and immediately squeegeed to provide a "band-aid" type effect approximately 50 mm (2 in.) wide flush with the pavement surface with the edges feathered out.

The sealant shall be allowed to cure before opening to traffic. The sealant should be tack free in about ten minutes. When necessary, the sealant may be dusted with sand or covered with tissue paper to prevent tracking.

The procedure for routing, cleaning and sealing longitudinal random cracks will be the same as the longitudinal shoulder joint, except the crack reservoir shall be sealed flush rather than providing an oversealed or "band-aid" type effect.

Transverse expansion joints shall be routed to create an approximate 25 mm (1 in.) deep reservoir. The walls of the joint shall be cleaned and refaced. The reservoir shall be filled flush with sealant.

Existing raised reflective pavement markers shall be protected during the crack or joint sealing operations. Tracking of bituminous materials or other sealant material will not be allowed. If bituminous materials or other sealant materials are applied to the markers, the Contractor shall remove such material to the satisfaction of the Engineer.

452.05 Method of Measurement.

- (a) Joint or Crack Routing or Sawing. Routed or sawed joints or cracks will be measured for payment in meters (feet) measured along the routed or sawed joint or crack.
- (b) Joint or Crack Filling. Filling of joints or cracks will be measured for payment in kilograms (pounds) of sealant used. The amount of sealant used will be determined by counting the containers or sealant used, multiplied by the indicated kilograms (pounds) of each container.

452.06 Basis of Payment. This work will be paid for at the contract unit price per meter (foot) for JOINT OR CRACK ROUTING (PC CONCRETE PAVEMENT AND SHOULDER) and JOINT OR CRACK ROUTING BITUMINOUS SHOULDER, and at the contract unit price per kilogram (pound) for JOINT OR CRACK FILLING.

Furnishing and installing backer rod when required by the Engineer will be paid for according to Article 109.04.

SECTION 480. EARTH SHOULDERS AND MEDIANS

480.01 Description. This work shall consist of placing, compacting, shaping and finishing earth, which is free from vegetation, roots, sod and other objectionable material, used in the construction of shoulders and medians.

CONSTRUCTION REQUIREMENTS

480.02 General. The Contractor shall at all times perform construction operations for the shoulders and medians in a manner such that the finished pavement, base or surface course, curb, gutter, curb and gutter, or any drainage structure will not be damaged by any of the equipment used. If the Engineer deems it necessary, the Engineer may require that all joints and edges be protected with a covering of earth, or by some other adequate means. If any completed or partially completed portion of the improvement, or any existing structure or portion thereof which is to remain in place is damaged or defaced during construction of the shoulders and medians, it shall either be repaired or removed and replaced by and at the expense of the Contractor, and to the satisfaction of the Engineer.

The shoulders and medians may be constructed and finished with a blade grader. The earth in shoulder and median areas shall be compacted as specified in Article 205.05, except that the earth in the area between curb or gutter and sidewalk shall be compacted in a manner meeting the approval of the Engineer. Prior to final blading and shaping of the shoulders and medians, they shall be rolled with a pneumatic-tired roller meeting the requirements of Article 1101.01.

480.03 Rigid Type Surfacing, Curb, Gutter, or Curb and Gutter. At locations where shoulders or medians are constructed adjacent to a portland cement concrete pavement, portland cement concrete base course, curb, gutter, or curb and gutter, placing of the earth for the shoulders or medians shall be completed and the earth compacted, shaped and finished to the lines, grades and cross sections shown on the plans after the surfacing, curb, gutter, or curb and gutter has been constructed.

480.04 Nonrigid Type Surfacing. At locations where shoulders or medians are constructed adjacent to nonrigid type surfacing such as aggregate base or surface course, or any bituminous surface course not constructed on a portland cement concrete base course, the following shall apply:

- (a) When the Base or Surface Course is constructed in a trench. Before the material for the base or surface course is deposited, earth shall be roughed in for the shoulders. The earth shall be placed so that it will be possible to retain and compact the edges of the base or surface course. After the base or surface course has been constructed, the balance of the earthwork required to complete the shoulders and median shall be performed, and the shoulders and median shall be shaped and trimmed to the lines, grades and cross sections shown on the plans.
- (b) When the Base or Surface Course is not constructed in a trench. Before the base or surface course is constructed, the earthwork required to complete the shoulders and median shall be shaped and trimmed to the lines, grades and cross sections shown on the plans.

480.05 Basis of Payment. This work will not be measured or paid for separately, but shall be considered as included in the contract unit price bid for the particular type of surface course, base course, or widening included in the contract.

SECTION 481. AGGREGATE SHOULDERS

481.01 Description. This work shall consist of furnishing, placing, shaping and compacting aggregate on a prepared subgrade adjacent to the edges of the completed pavement structure or stabilized shoulder.

481.02 Materials. Materials shall meet the requirements of the following Article of Section 1000 - Materials:

Item	Article/Section
(a) Aggregate	1004.04

Note: Reclaimed asphalt pavement (RAP) may be used as aggregate in surface course for aggregate shoulders Type B. The RAP material shall be reclaimed asphalt pavement material resulting from the cold milling or crushing of an existing hot-mix bituminous concrete pavement structure, including shoulders, which was built under state contract and met Department specifications at the time of original placement. RAP containing contaminants such as earth, brick, concrete, sheet asphalt, sand, or other materials identified by the Department will be unacceptable until the contaminants are thoroughly removed. The Contractor shall inform the Engineer as to the location of the originally placed pavement prior to the RAP being used. The RAP shall also meet the following requirements:

One hundred percent of the RAP material shall pass the 37.5 mm (1 1/2 in.) sieve. The RAP material shall be reasonably well graded from coarse to fine. RAP material that is gap-graded or single sized will not be accepted.

481.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100 - Equipment:

Item	Article/Section
(a) Tamping Roller	1101.01
(b) Pneumatic-Tired Roller	1101.01
(c) Three-Wheel Roller	1101.01
(d) Tandem Roller	1101.01
(e) Vibratory Machine (Note 1)	
(f) Spreader	1102.04

Note 1. The vibratory machine shall meet the approval of the Engineer.

CONSTRUCTION REQUIREMENTS

481.04 General. The road shall be opened to traffic according to Article 701.05(a)(1). Before placing the aggregate the subgrade shall be prepared in a manner approved by the Engineer.

The shoulders shall be constructed in layers of not more than 150 mm (6 in.) thick when compacted, except that if tests indicate the desired results are being obtained, the compacted thickness of any layer may be increased to a maximum of

200 mm (8 in.). The aggregate shall be deposited directly on the prepared subgrade or on the preceding layer of compacted aggregate with a spreader.

If any subgrade material is worked into the aggregate during the compacting or finishing operation, all granular material within the affected area shall be removed and replaced with new aggregate.

The shoulders shall be constructed to the thicknesses shown on the plans. Thickness determinations shall be made at such points as the Engineer may select. When the constructed thicknesses are less than 90 percent of the thicknesses shown on the plans, aggregate shall be added to obtain the required thicknesses; however, the surface elevation of the completed shoulders shall not exceed by more than 3 mm (1/8 in.) the surface elevation shown on the plans or authorized by the Engineer.

- (a) Aggregate Shoulders, Type A. Before the aggregate is deposited on the subgrade, it shall contain sufficient moisture to provide satisfactory compaction. The water and aggregate shall be mixed at a central mixing plant. The plant shall be equipped with a mechanical mixing device, and aggregate and water measuring devices, meeting the approval of the Engineer. Wetting the aggregate in cars, bins, stockpiles or trucks will not be permitted.

Each layer of material shall be compacted with a tamping roller, or with a pneumatic-tired roller, or with a vibratory machine, or with a combination of any of the three until the compaction has been approved by the Engineer. If the moisture content of the material is not such as to permit satisfactory compaction during the compacting operations, water shall be added in such quantity that satisfactory compaction can be obtained. The top layer shall be given a final rolling with a three-wheel or tandem roller. Three-wheel or tandem rollers shall weigh from 5.5 to 9 metric tons (6 to 10 tons) and not less than 35 N/mm (200 lb/in.) nor more than 55 N/mm (325 lb/in.) of width of the roller.

- (b) Aggregate Shoulders, Type B. Before placing the aggregate wedge shoulder, Type B, the weeds and grass on the area to be covered shall be cut. The aggregate shall be deposited in its final position with a spreader and compacted to the satisfaction of the Engineer. If the moisture content of the aggregate is not such as to permit satisfactory compaction during the rolling operations, water shall be added in such quantity that satisfactory compaction can be obtained.

481.05 Method of Measurement. The aggregate for constructing the shoulders will be measured for payment in metric tons (tons), in cubic meters (cubic yards), or in square meters (square yards), and according to Article 311.08, except payment will not be made for aggregate outside the plan width. The unit of measure will be as shown on the plans.

481.06 Basis of Payment. This work will be paid for at the contract unit price per metric ton (ton) or per cubic meter (cubic yard) for AGGREGATE SHOULDERS, TYPE A, or AGGREGATE SHOULDERS, TYPE B; or at the contract unit price per square meter (square yard) for AGGREGATE SHOULDERS, TYPE A, or AGGREGATE SHOULDERS, TYPE B, of the thickness specified.

SECTION 482. BITUMINOUS SHOULDERS

482.01 Description. This work shall consist of constructing a bituminous shoulder on a prepared subgrade, existing paved shoulder, or subbase.

482.02 Materials. Materials shall meet the requirements of Article 312.03, except that aggregate which does not meet the requirements of Article 1004.04(c) and liquid asphalt MC-3000 will not be permitted.

For the 50 mm (2 in.) top lift, the aggregate used shall meet the gradation requirements for a CA 10. Blending of aggregates at the plant in order to meet the requirements for a CA 10 or CA 12 will be permitted.

482.03 Equipment. The equipment shall meet the requirements of Article 312.04.

CONSTRUCTION REQUIREMENTS

482.04 General. For pavement and shoulder resurfacing projects, Class I Binder and Surface Course (Type 1 or Type 2) mixtures may be used in lieu of Bituminous Aggregate Mixture for the resurfacing of shoulders, at the option of the Contractor.

For the construction of shoulder strips for pavement resurfacing, Class I Binder and Surface Course mixtures shall be used.

The methods used in performing this work shall meet the following requirements:

Item	Article/Section
(a) General Conditions	312.05
(b) Preparation of Bituminous Material	312.07
(c) Preparation of Bituminous Aggregate Mixture	312.08
(d) Transportation of Bituminous Aggregate Mixture	312.09

Whenever bituminous shoulders are constructed adjacent to a pavement constructed on an improved subgrade and additional material is needed to extend the improved subgrade to the bottom of the bituminous shoulder, the additional material shall be subbase granular material, Type C, conforming to Section 311. The work of constructing this additional thickness of material will not be paid for separately, but shall be considered as included in the contract unit price bid for the item of the improved subgrade.

482.05 Composition of Bituminous Aggregate Mixture. The composition of the mixture shall be according to Article 312.06, except that the amount of bitumen used in the top lift shall be increased up to 0.5 percent more than that required in the lower lifts. For resurfacing projects when the Class I Mixture option is used, the bitumen used in the top lift shall not be increased. Class I Mixtures used on the top lift of such shoulders shall meet the gradation requirements of a B Binder or a

Surface Course mixture according to Article 406.13 and the following requirements as determined by mixture design made in the laboratory:

50-Blow Marshall Mix Design

<u>Min.</u> <u>Stability kN (lb)</u>	<u>Maximum</u> <u>Flow 0.25 mm (0.01 in.)</u>
6.6 (1500)	19

For shoulder strip construction, the composition of the Class I Binder and surface course shall be the same as that specified for the main line pavement.

482.06 Placing and Compacting. This work shall be accomplished according to Article 312.10, except the density of the first layer shall be not less than 90 percent of the theoretical density and subsequent layers shall be compacted to not less than 92 percent of the theoretical density. The density shall be obtained by an approved vibratory compactor and a roller or by the use of two rollers. If the Contractor demonstrates an alternate method of compaction that will result in obtaining the required density, it may be used subject to the approval of the Engineer as provided in Article 108.06. The top lift shall be a nominal 50 mm (2 in.) compacted layer. The mechanical spreader for the top 50 mm (2 in.) lift of shoulders shall meet the requirements of Article 1102.03 when the shoulder width is 3 m (10 ft) or greater. The bottom lift or lifts of shoulders shall be placed with a machine operated on the pavement.

When the Class I mixture option is used on resurfacing projects, shoulder resurfacing widths of 1.8 m (6 ft) or less may be placed, at the Contractor's option, simultaneously with the adjacent traffic lane for both the binder and surface courses, provided the specified density, thickness and cross slope of both the pavement and shoulder can be satisfactorily obtained. The paver shall operate with both tracks/drive wheels on the traffic lane. Shoulder resurfacing greater than 1.8 m (6 ft) in width shall be placed in a separate operation.

When rumble strips are required, they shall be formed by use of a modified roller drum after finish rolling. The drum roller shall be modified to create a rumble strip pattern shown on the plans. The Contractor shall have the option of using either continuous or intermittent corrugations. The corrugations shall be perpendicular to the pavement edge and shall be omitted when falling within the limits of a side road, entrance or ramp entrance and exit. The roller shall be equipped with a sighting device to enable the operation to maintain proper alignment, and shall have a minimum weight of 9 metric tons (10 tons) or be of sufficient weight to obtain the desired results as directed by the Engineer. After the rumble strips are formed, a final pass with a finish roller shall be made when directed by the Engineer.

The Class I Binder portion of shoulder strips constructed simultaneously with pavement resurfacing may be constructed in one or two lifts. If the plans call for the pavement to be resurfaced with Class I Surface Course only, the entire safety shoulder may be constructed with surface course, except that the portion normally constructed with binder shall be placed and compacted separately.

482.07 Tolerance in Thickness. The shoulder shall be constructed to the thickness shown on the plans. When the contract includes square meters (square yards) as the unit of measurement for Bituminous Shoulder, thickness determinations shall be made at such points as the Engineer may select. When the constructed thickness is less than 90 percent of the specified thickness, it shall be brought to specified thickness by the addition of the applicable mixture or by removal and replacement with a new mixture. However, the surface elevation of the completed shoulder shall not exceed by more than 3 mm (1/8 in.) the surface elevation shown on the plans or authorized by the Engineer.

482.08 Method of Measurement.

- (a) Contract Quantities. The requirements for the use of Contract Quantities shall conform to Article 202.07(a).
- (b) Measured Quantities. When bituminous shoulders are constructed along the edges of the completed pavement structure, bituminous shoulders will be measured for payment in place and the area computed in square meters (square yards). The width for measurement will be from the edge of the pavement to the top edge of the bituminous shoulder as shown on the plans or as directed by the Engineer.

On pavement and shoulder resurfacing projects, bituminous shoulders will be measured for payment in metric tons (tons) according to Article 406.23, except that the requirement that payment will not be made for any bituminous concrete mixture in excess of 103 percent of the quantity specified by the Engineer will not apply. When shoulder resurfacing is placed simultaneously with the adjacent traffic lane or when a bituminous wedge is placed simultaneously with the binder course on the traffic lane as specified in Article 406.20, the quantity of bituminous shoulders will be measured for payment as specified in Article 406.23.

The Class I binder and surface course mixtures used in construction of shoulder strips for pavement resurfacing will be measured for payment in metric tons (tons) as specified in Article 406.23, except that the thickness of surface course will be limited to that specified for the adjacent resurfacing. Surface course used in excess of this amount will be measured for payment as binder course.

482.09 Basis of Payment. When bituminous shoulders are constructed along the edges of the completed pavement structure, this work will be paid for at the contract unit price per square meter (square yard) for BITUMINOUS SHOULDERS of the thickness specified. The specified thickness shall be the thickness shown on the plans at the edge of the pavement.

On pavement and shoulder resurfacing projects, the shoulder resurfacing will be paid for at the contract unit price per metric ton (ton) for BITUMINOUS SHOULDERS.

The construction of shoulder strips for resurfacing pavements will be paid for as bituminous concrete binder course or bituminous concrete surface course, Class I, according to Section 406.

SECTION 483. PORTLAND CEMENT CONCRETE SHOULDERS

483.01 Description. This work shall consist of constructing a portland cement concrete shoulder on a prepared subgrade or subbase adjacent to the edges of the completed pavement structure.

483.02 Materials. Materials shall meet the requirements of the following Articles of Section 1000 - Materials:

Item	Article/Section
(a) Portland Cement Concrete	1020
(b) Tie Bars (Note 1)	1006.10
(c) Poured Joint Sealer	1050
(d) Protective Coat	1023.01

Note 1. Tie bars shall be epoxy coated.

483.03 Equipment. Equipment shall meet the requirements of the following Articles of Section 1100:

Item	Article/Section
(a) Forms for Pavement	1103.05
(b) Form Grader	1103.06
(c) Formless Paver	1103.16
(d) Water Supply Equipment	1103.11
(e) Batching and Weighing Equipment	1103.02, 1103.03
(f) Paving Mixer (and Water Measuring Equipment)	1103.01
(g) Truck Agitator	1103.01
(h) Heavy Subgrade Template	1103.10
(i) Mechanical Form Tamper	1103.07
(j) Miscellaneous Equipment	1103.17
(k) Membrane Curing Equipment	1101.09

CONSTRUCTION REQUIREMENTS

483.04 General. Portland cement concrete shoulders shall be constructed according to the applicable portions of Articles 420.04 through 420.21 except as specified in the following articles.

483.05 Subgrade. The work of constructing this additional thickness of material will not be paid for separately, but shall be considered as included in the contract unit price bid for the item of the improved subgrade.

483.06 Placing and Finishing. If the placement of concrete shoulders requires mechanical equipment to operate on the adjacent lane of pavement, that lane shall have attained the strength specified for 14 day concrete. If only finishing equipment is to be operated on the edge of the adjacent lane, shoulder placement may be permitted after three days. Prior to placing the shoulders, all joints in the adjacent pavement shall be permanently sealed according to Article 420.14. The jute

roping or soft cotton rope interim seal will not be permitted. In addition, the pavement edge at all transverse joints shall be sealed or caulked to prevent the intrusion of mortar from the shoulder placing operation into the joint.

If forms are used, they shall be set and removed according to Articles 420.06 and 420.13, respectively. A mechanical spreader and finishing machine will not be required. The concrete may be struck off and consolidated using a vibrating screed approved by the Engineer.

If the slip form method is used, the slip form paving equipment may operate from the adjacent lane or on tracks spanning the shoulder area. The slip form equipment shall vibrate the concrete either externally or internally with sufficient intensity to consolidate the concrete throughout its entire depth and width. The concrete shall be consolidated and finished true to grade and cross section in one pass in a manner such that a minimum of hand floating will be required. The tolerance for edge slump shall be according to Article 420.17(a).

Prior to the final finish, the shoulder shall be straightedge tested and corrected according to Article 420.11(c). When forms are used, the outer edge of the shoulder shall be finished with an edging tool. The final finish shall be according to Article 420.11(e)(1), Type A. If rumble strips are required, they shall be formed in the surface of the shoulder according to the details shown on the plans and in a manner satisfactory to the Engineer immediately after the application of the final finish. The corrugations shall be perpendicular to the pavement edge and shall be omitted when falling within the limits of a side road, entrance or ramp entrance and exit.

483.07 Joints. The longitudinal construction joint between pavement and shoulder shall be tied with epoxy-coated deformed tie bars according to the details shown on the plans and as specified in Article 420.10(b). The joint shall be sealed as specified in Article 420.14.

Contraction and expansion joints in portland cement concrete shoulders shall be extensions of contraction and expansion joints in the adjacent pavement.

Transverse construction joints in concrete shoulders shall be constructed according to the details shown on the plans. Transverse construction joints shall be the prolongation of the joint in the adjacent pavement. For other types of concrete pavement, transverse construction joints in the shoulder shall be located midway between shoulder contraction joints.

483.08 Surface Test. The requirements of Article 420.12 for surface tests does not apply to portland cement concrete shoulders.

483.09 Tolerance in Thickness. The shoulder shall be constructed to the thickness shown on the plans. Thickness determinations shall be made at such points as the Engineer may select. When the constructed thickness is less than 90 percent of the specified thickness, such thin shoulder shall be removed and replaced at the Contractor's expense.

483.10 Opening to Traffic. The shoulders shall be open to traffic according to Article 701.05(a)(2).

483.11 Method of Measurement.

- (a) Contract Quantities. The requirements for the use of contract quantities shall conform to Article 202.07(a).
- (b) Measured Quantities. Portland cement concrete shoulders will be measured for payment in place and the area computed in square meters (square yards). The width for measurement will be from the edge of the pavement to the edge of the portland cement concrete shoulder as shown on the plans or as directed by the Engineer.

The area of shoulder upon which the protective coat is applied will be measured for payment in place and the area computed in square meters (square yards).

| Tie bars will be measured according to Article 508.07.

483.12 Basis of Payment. This work will be paid for at the contract unit price per square meter (square yard) for PORTLAND CEMENT CONCRETE SHOULDERS of the thickness specified. The specified thickness shall be the thickness shown on the plans at the edge of the pavement.

If a protective coat is applied, it will be paid for at the contract unit price per square meter (square yard) for PROTECTIVE COAT, which price shall be payment in full for cleaning the surface of the shoulder and for the two applications. No additional compensation will be allowed the Contractor if all or a portion of the quantity of Protective Coat is deducted from the contract.